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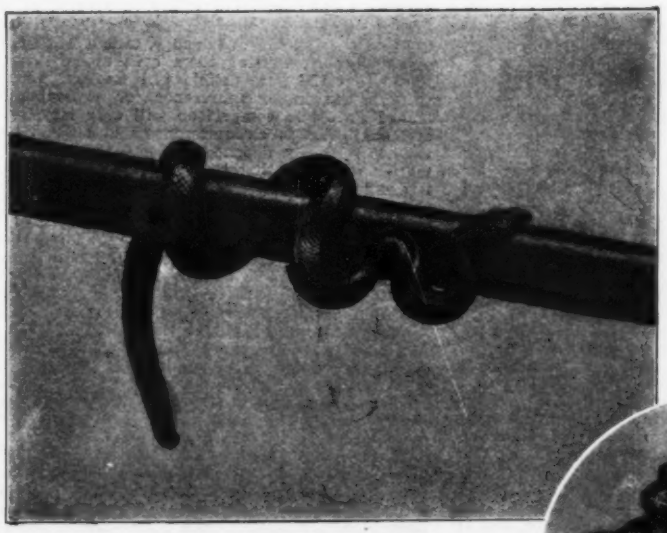
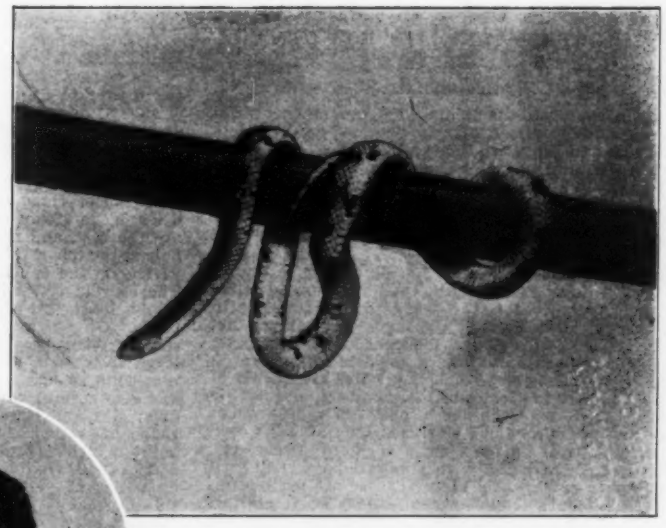
BLACK-CHEEKED MONKEY.

THE FRINGED GECKO.

THE INDIAN MACAQUE.

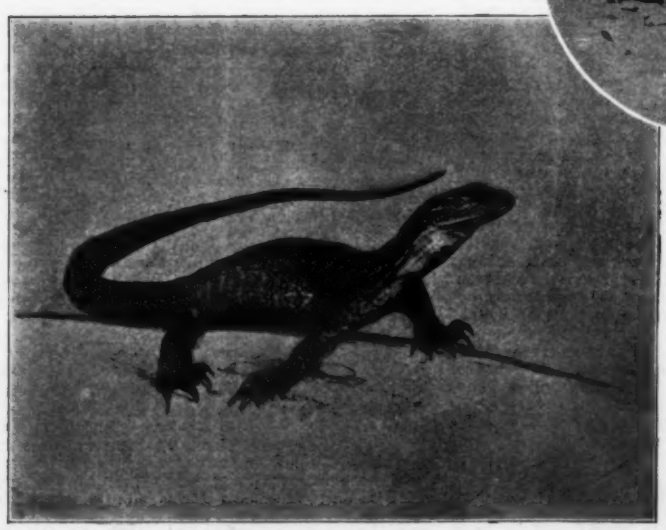


THE ROBBEN ISLAND SNAKE.



THE MEXICAN BULL SNAKE.

THE TIGRINE FROG.



GOULD'S MONITOR.

LAND IGUANA.

RARE ANIMALS IN THE LONDON ZOO.

SOME NEW ARRIVALS AT THE LONDON ZOO.

WE publish on our title page some cuts of a selection of interesting animals recently added to the London Zoological Gardens. Two of the specimens belong to the highest among the natural orders, the primates. The one is a black-cheeked monkey, from West Africa. The other, the Indian macaque, presents some interesting peculiarities. This ape belongs to the sub-family of the Cynopithecinæ, which are characterized among other things by the absence of the vermiform appendix, which in man is often a source of severe trouble. The Indian macaque is very light colored, almost white in great part. It is interesting to note that the few existing European ape species are closely allied to the macaque.

Five of the other specimens shown in our illustration belong to the order of reptiles. Two are snakes—the Robben Island snake hails from South Africa, while the other is a bull snake from Mexico.

In the center of the page is depicted a Tigrine frog, native of North America. This is a very large representative of the order of Anura, to which the common frog and toad also belong. A full-grown individual will measure as much as eight inches from end to end, and his mouth is sufficiently large and strong to make him a formidable enemy to water-rats and young birds.

The remaining three specimens are lacertilia. There is a Gould's monitor from Australia, a fringed gecko from Madagascar, and a land iguana from the Galapagos Islands.

The geckoes are small lizard-like animals, lacking, however, that litheness and grace which is characteristic of the common lizard. Their movements are slow and awkward, the legs are short, and the body trails somewhat on the ground. The head is broad and flat and the eyes very large. In the countries where they occur an unfounded prejudice is commonly entertained against these animals, which are not only harmless, but quite on the contrary are extremely useful, as they destroy insects and worms, on which they feed. Some species of geckoes possess in a limited degree the power of changing their color in chameleon fashion.

The iguanas form a large family of lizards, which with one exception are found in the New World only, being specially characteristic of the neotropical regions, where they occur as far south as Patagonia, while extending as far north as California and British Columbia. The typical forms are distinguished by a large pouch under the head and neck and by a crest composed of slender, elongated scales and extending in gradually diminishing height from the nape of the neck to the tip of the tail.

These characteristics are more or less clearly shown in the land iguana from the Galapagos Islands, shown in our illustration. He is, however, distinguished from most other iguanas in that he lives in burrows which he makes in the ground.—Our pictures are taken from the Illustrated London News.

SPONGES—WHERE THEY LIVE, HOW OBTAINED AND THEIR USES.*

By ALBERT HART.

SPONGE belongs to the animal kingdom, and the principal ones used commercially are obtained on the coasts of Florida and the West Indies; the higher grades are from the Mediterranean Sea, and are numerous in variety.

A sponge in its natural state is a different looking object from what we see in commerce, resembling somewhat the appearance of the jelly-fish, or mass of liver, the entire surface being covered with a thin, slimy skin, usually of a dark color, and perforated to correspond with the apertures of the canals commonly called "holes of the sponge." The sponge of commerce is in reality only the skeleton of a sponge. The composition of this skeleton varies in the different kinds of sponges, but in the commercial grades it consists of interwoven horny fibers, among and supporting which are spiculæ of silicious matter in greater or less numbers, and having a variety of forms. The fibers consist of a network of fibrils, whose softness and elasticity determine the commercial quality of a given sponge. The horny framework is perforated externally by very minute pores, and by a less number of larger openings. These are parts of an interesting double canal system, an external and an internal, or a centripetal and a centrifugal. At the smaller openings on the sponge's surface channels begin, which lead into dilated spaces. In these, in turn, channels arise, which eventually terminate in the large openings. Through these channels or canals definite currents are constantly maintained, which are essential to the existence of the sponge. The currents enter through the small apertures and emerge through the large ones.

The active part of the sponge, that is, the part concerned in nutrition and growth, is a soft, fleshy mass, partly filling the meshes and lining the canals. It consists largely of cells having different functions; some utilized in the formation of the framework, some in digestion, and others in reproduction. Lining the dilated spaces into which different canals lead are cells surmounted by whip-like processes. The motion of these processes produces and maintains the water currents, which carry the minute food-products to the digestive cells in the same cavities. Sponges multiply by the union of sexual product. Certain cells of the fleshy pulp assume the character of ova, and others that of spermatozoa. Fertilization takes place within the sponge. The fertilized eggs, which are called larvæ, pass out into the currents of the water, and, in the course of twenty-four to forty-eight hours, they settle and become attached to rocks and other hard substances, and in time develop into mature sponges. The depth of the water in which sponge grows varies from 10 to 50 feet in Florida, but considerably more in the Mediterranean Sea, the finer grades being found in the deepest water, having a temperature of 50 deg. to 57 deg.

The method of obtaining sponges in the Mediterranean is by means of divers with apparatus, though this was prohibited by the Turkish government many years ago, but not adhered to, owing to the lack of support by the Greek government, and to excessive fishing, thus deteriorating the sponge beds, which require about three years to properly develop. As a consequence, these goods have become scarce, and greatly enhanced in value. A diver usually stays below the water a half to one minute, gathering what he can in the meantime, though, with apparatus, he can remain below the surface a considerable time. His work is very hard, owing to the pressure of the water. He is trained to his work when very young, and seldom lives more than thirty years. In the Florida and West India waters, the fishing is done in flat-bottom boats, called dingies. A tin or wooden pail with a glass bottom is used to help locate the sponges, by lowering it into the water, and looking down through it. When located, they are brought up by means of a long pole, about thirty feet long, with a sharp-curved, double hook, by which means they are detached and brought to the surface. After obtaining a boatload it is laid out to decompose, a process better observed from a distance, owing to the obnoxious odor. They are laid out in kraals on the beach, and so washed by the sea. After the cleaning process, they are taken to the market, and sold to the dealers, who are experts, the highest bidder becoming the purchaser. They are then sorted and packed into bales, according to size and quality. Of commercial sponges, there are many different varieties, namely: sheepswool, velvet, yellow, grass, glove, reef, hardhead, and wire, emanating from Florida and the West Indies, each variety having several different grades, the Mediterranean giving us honeycomb sponges, commonly called "Turkish bath," "Turkey sponges" (i. e., silk surgeon sponges), leather sponges (i. e., elephant ears or washrag sponges), there being also several different grades of each variety. Sheepswool are named Rock Islands; Key, Matacomby (obtained from Florida); Abaco, Cuba; and Nassau from the West Indies, their names being given in order as to quality, the most valuable being Rock Islands, which are of a strong fiber and best form, being most valuable for carriage washing and heavy work. This grade also makes fine bath sponges, either bleached with permanganate of potash, muriatic acid and oxalic acid, which makes them a white color, and then washed in a bath of sal soda or lime water, thus neutralizing the acid and changing the color yellow or lemon. This method, however, greatly weakens the fiber of the sponge, thus ruining it as regards durability. A better method, though not so pleasing to the eye, is to wash the natural sponge in a weak solution of oil of vitriol, say one part of acid to twenty of water, allowing them to remain in until the dark color is taken out of the sponge, then thoroughly washing in water. This process does not injure the sponge, and makes it look cleaner.

Key sheepswool is a good form, soft and close fiber, lacking strength, owing to the iron in the sponge, which is signified by a bright-red color at the root, and running entirely through the structure of the sponge. It is extensively bleached and looks nice, but wears badly, owing to the excessive use of acids necessary to abstract the iron from the sponge.

Abaco sheepswool somewhat resembles the Rock Island though lacking its strength.

The Cuba sheepswool resembles the Key variety, being lighter in color.

The Nassau is the coarsest grade and is irregular as regards the horny fibers, firmness and shape.

The velvet sponges, of which there are several varieties, i. e., Abaco, Cuba and Cay from the West Indies, also a hard variety from Florida, are much used as cheap carriage sponges, and for general purposes, being moderate in price. The Abaco and Cuba velvet are the best, and much resemble sheepswool. A large hole at the top of this sponge spoils its utility. The Cay variety is the one largely used, being more abundant. The Florida velvet is coarse and hard, and is not generally liked, except for certain manufacturing purposes. Owing to a hole in the top of this grade of sponge, many people prefer the cut sponges, i. e., the large sponges cut up and trimmed, thus obtaining a nice solid sponge minus the holes. The yellow sponge has also several varieties—Nassau, from the West Indies; Key and Matacomby, Florida, which are a good shape, but rather brittle, and are used chiefly among the painters, bricklayers, and for household purposes. The best of these are the Matacomby and Key. There is also a species of yellow sponge called "hard head," and this is what its name implies—a "hard" sponge. One variety, however, from Cuba, has a fine texture, and is soft, though somewhat brittle.

The grass sponge is of a very poor species, and very low in price. It is chiefly used for manufacturing purposes by painters, stone-masons, bricklayers, etc. The best quality and nicest shapes are bleached and sold on the market for a cheap bath sponge, and are as good in appearance as the higher grades, but give no satisfaction in wear.

The reef sponges are fine in texture, but lack strength, are extensively bleached for toilet purposes, and used by manufacturers and engravers.

Sponges from the Mediterranean Sea are superior in quality to either the Florida or West Indies. The horny fibers being far less pronounced, they do not develop to the same thickness. They are finer in texture, and more pliable, and grow in deeper water, having a surface temperature of 50 deg. to 57 deg. in winter, which is clearer and more free from impurities, and the more difficult to obtain. The various grades are called white Turkey, i. e., silk surgeon sponges; brown Turkish, i. e., Zinocha, being similar to the silk sponge, only coarser and darker in color; leather sponges, i. e., wash-rag or elephant's ears and honeycomb sponges; all of which have several different varieties. The best varieties are Mandruka Turkey cups, deriving their name from their formation, similar to a cup; Turkey solids, which are the same variety, only solid, as the name implies. The leather sponges are thin, flat, and fine in texture, used chiefly for manufacturing purposes, and used considerably in Europe by veterinary surgeons. Brown Turkey, i. e., Zinocha sponges, are similar in texture to a silk sponge, but brittle. It is chiefly used in Europe for a horse sponge, and also for manufacturing purposes. Honeycomb sponges are various in quality, these being known as Mandruka, and found in deep water, are perfect forms, and have a close fiber and no horny fibers protruding from the surface, and are characteristic for their small root. This latter fact should be borne in mind in selling sponges. Many people object to large holes in the sponge, whereas, the root is the chief factor in determining its strength. The "catch" of this grade is diminishing yearly, thereby enhancing their value, consequently only a few dealers import them, the largest supply coming to Philadelphia.

Next in quality comes the Bengaza, a sponge similar to the Mandruka, though somewhat coarser, but a nice shape and strong, and is usually sold as a "Mandruka." This sponge grows in deep water. The cheaper varieties of honeycomb, i. e., Turkish bath, are found in shallow water, and are numerous in variety, quality varying according to depth at which they are found. They are chiefly bleached, only the finest selected being used in their natural color.

The question of propagating sponges has been discussed both as regards Florida and Mediterranean sponges, and the idea is believed to be feasible. The method is as follows: Sponges cut into small pieces will live and grow, if properly attached in suitable water (clear and free from impurities). They can be cut on a moistened board with a knife or a fine saw. Care must be taken not to express the soft matter. The preferred size of the cuttings is about one inch broad and similar in height. The outer skin should be retained as far as practicable. In cutting, the lines of the circulating canals should probably be considered, although pieces cut without any reference to the direction of the canals have lived and grown. Exposure is not injurious, unless exposed too long or in very warm weather. The clippings must then be made fast, care must be taken to use material that is not injurious to the sponge, and will not distort its growth. They must be fastened on the bottom in an upright position that can be maintained, and not smothered by mud, sand or sediment. The use of bamboo pegs seems to have given much satisfaction and good results attained in as short a time as a year.

Owing to the great advance in the cost of sponges during the last few years, due to the scarcity and the results of overfishing and increased demand, of which the European market has been a factor, the packers in Florida have resorted to loading sponges to keep down the price, so as to appear to continue asking the former prices, whereas in reality, the cost is 20 to 35 per cent higher. There are several methods of accomplishing this, such as injecting into the sponge sand and marble-dust; also by washing the sponges in a salt solution and by injecting glucose and heavy syrups. In fact, so heavy do they endeavor to load them, that it is a wonder that the government did not contract for loaded sponges for their cannon in its late war with Spain. Dealers now offering pure sponges free from sand and foreign matter are practically ridiculed by retailers, when quoting $1 and $1.50 per pound higher than their competitors offering loaded sponges, though they are offering the better and cheaper article, and not likely to scratch or spoil a highly polished article. To compare the difference between a pure and loaded sponge, take a 2 ounce sponge of each grade, wetting them both up, and it will be found that the pure article will measure about nineteen inches in circumference, or thereabout. The loaded article in comparison will only measure about sixteen inches in circumference and less. Of course, this will largely depend upon the amount of foreign matter contained therein, the average herein given being taken from a bale of each kind and measured. Take a sponge of equal weight, say 2 ounces, costing $4 a pound and pure, and a loaded sponge at $3 per pound, and it will be seen that by washing them out, you are getting a larger sponge in the 2 ounce pure than in the 2 ounce loaded, and therefore the cost is practically equal, despite the fact of there being $1 in difference per pound in the price. A bale of pure sponges averaging eight to the pound at $4 a pound will be as large if not larger than a loaded bale about six to the pound, at $3 per pound. The cost of both of these, per sponge, is 50 cents. The purchasing of loaded sponges should, therefore, be avoided, it being illustrated that as good value, if not better, can be obtained by paying the higher price.

Many dealers are now offering sheepswool by the piece, a stated number of sponges being packed in a bale, and this method is commended, saving the retailer the trouble of figuring the individual cost of each sponge, and sometimes unconsciously losing their profits by not taking into consideration the difference of gross weight at which the sponges are usually purchased, and the net weight, and even a possible loss from the sponge drying out. In this connection we would say that sponges in bales absorb the humidity in the summer time, and are usually more or less damp, whereas, in the winter time, they lose in weight, owing to the dryness of the air.

* American Journal of Pharmacy.

SOME PECULIAR ANIMAL PRODUCTS.*

By R. LYDEKKER.

OF animal wax other than spermaceti (the product of the sperm-whale and certain other allied species) the great producer is the familiar honey-bee, an insect which has been kept in a state of semi-domestication from time immemorial, and is now spread over the greater part of the habitable globe, existing in certain countries in the wild condition. Its original home is, however, quite unknown; and it is doubtful if any of the wild bees of this species are the descendants of primitively wild ancestors. In southern Europe, as well as in China and Africa, varieties of the honey-bee are met with characterized by the presence of well-marked transverse bands on the body.

As is well known, the wax is secreted by the neuters, or workers, from between the segments of the abdomen. When secreting—a process which occupies about twenty-four hours—the workers cling to one another so as to form long festoon-like masses; the wax exuding as thin plates from between the abdominal segments. These plates are detached by the bees, and conveyed in fragments to the mouth, where they are masticated, and from which they finally issue in the form of a narrow white ribbon. To describe the man-

* Knowledge.

ner in which the hexagonal-celled combs are built up from the wax thus formed, would be superfluous in the present article. Neither is it necessary to describe the collecting and melting down of the combs to form commercial wax. Nearly related to the honey-bee are certain smaller species inhabiting the warmer parts of South America, and referred to distinct genera, under the names of *Melipona*, *Trigona*, etc. These likewise build cells with wax, but whether in sufficient quantities to be of any commercial importance, we have not been able to ascertain.

The Chinese obtain a large quantity of excellent wax from an insect they term *pela*, which is a member of the order Rhynchota, and is technically known as *Ceroplastes sinensis*. This insect lives on trees, and is artificially propagated; its wax being employed for the manufacture of the candles used in the Buddhist temples of China and Japan, as well as for medical purposes. An allied species of wax-insect (*Ceroplastes ceriferus*) is found in Ranchi and other districts of India, clinging to the branches of certain kinds of trees, more especially the arjuse, a species of *Terminalia*. As is the case with the Chinese insect, it is the female alone which produces the secretion; this in the present case taking the form of small masses of pure white wax. The late Prof. V. Ball writes as follows concerning this species: "The Indian wax-insect has never, I believe, been propagated, nor has the wild product ever been collected in quantity. It seems to be—although undoubtedly of value—a substance which would scarcely repay an expenditure of European time and capital; but were the natives to take up its cultivation they might very possibly make it a profitable undertaking."

Of very considerable commercial importance is the resinous substance known as lac, since it forms the foundation of most varnishes, and is also employed in the manufacture of sealing-wax, etc. It is the product of the lac-insect (*Carteria lacca*), an inhabitant of India and other Oriental countries, and a near relation of the cochineal-insect, as well as a distant cousin of the plant-lice, or aphides. This insect gives rise to a resinous exudation from the bark of the trees it frequents, which, while still adhering to the twigs, is termed stick-lac. When pounded and freed from coloring matter, this substance forms the seed-lac and shellac of commerce; while the liberated coloring matter constitutes lac-dye. As neither the resinous matter nor the dye is obtained from the body of the insect, they are not, properly speaking, animal products. Nevertheless, as they are caused by the presence of the insect, and are always spoken of in connection with the latter, they should be considered with such products.

Owing to sudden and large fluctuations in the price of lac in the London market, the trade is a somewhat risky one; the profits made in one year being not unfrequently swallowed up by the losses of its successor. Here it may be mentioned that the word lac, or lakh, is the Hindustani term for 100,000, and is applied to the insect on account of its numbers, while it is also in general use to denote the sum of 100,000 rupees.

The following account of the collection and manufacture of lac in the Ranchi district, India, is given by the writer just cited.* After mentioning that the lac-insect frequents the twigs of various jungle trees, and more especially three particular species, Prof. Ball proceeds as follows: "To some extent the lac is found occurring, so to speak, spontaneously, and is collected by the forest tribes, and brought by them to the fairs and bazars for sale. Where, however, there is a regular trade in stick-lac, propagation of the insect is systematically carried on by those who wish for a certain and abundant crop. This propagation is effected by tying small twigs, on which are crowded the eggs or larvæ of the insect, to the branches of the trees. These larvæ are technically called 'seed.' The larvæ shortly after sowing spread themselves over the branches, and, taking up positions, secrete round themselves a hard crust of lac, which gradually spreads till it nearly completes the circle round the twig. At the proper season the twigs are broken off, and we must suppose them to have passed through several hands, or to have been purchased directly from the collectors by the agents of the manufacturer. On arrival at the factory, they are first placed between two powerful rollers which, by a simple arrangement, admit of any degree of approximation. The lac is then crushed off, and separated from the woody portions by screening; it is next placed in large tubs half-full of water and washed by coolies, who standing in the tubs, and holding a bar with their hands, stamp and pivot about on their heels and toes until, after a succession of changes, the resulting liquor comes off clear. . . . The lac, having been dried, is placed in long cylindrical bags of cotton cloth of medium texture, which are about ten feet long and two inches in diameter. These bags when filled have somewhat the appearance of an enormous bologna sausage. They are taken to an apartment where there are a number of open charcoal furnaces, before each of which there is one principal operator with two assistants. The former grasps one end of the long sausage in his left hand, and slowly revolves it in front of the fire; at the same time one of the assistants, seated as far off as the sausage is long, twists it in the opposite direction. The roasting before the glowing charcoal soon melts the lac in the portion nearest the operator's hand, and the twisting of the cloth causes it to exude and drop into a trough placed below. The troughs which I saw in use were simply leaves of the American aloe. When a sufficient quantity in a molten condition is ready in the trough, the operator takes it up in a wooden spoon and places it on a wooden cylinder some eight or ten inches in diameter, the upper half of which is covered with sheet brass. The stand which supports this cylinder gives it a sloping direction away from the operator. The other assistant now steps forward holding a strip of the aloe between his hands, and with a rapid and dexterous draw of this, the lac is at once spread into a sheet of uniform thickness which covers the upper portion of the cylinder. The operator now cuts off the upper edge with a pair of scissors, and the sheet is then lifted up by the assistant, who waves it about a moment or two in the air, until it becomes quite crisp. It is then held up to the light, and any impurities, technically 'grit,' are punched out of the brittle sheet by the finger. . . . The sheets are placed in packing-cases, and when subjected to pressure break into numbers of fragments."

Previous to the discovery and extensive employment of aniline colors the substance known as lac-dye formed an important and valuable item among Oriental animal products. As already mentioned, it is obtained by washing stick-lac in the course of its conversion into shell-lac. Unlike the latter substance it appears, however, to be of exclusively animal origin, being in fact the actual body of the lac-insect, and not a separate secretion.

In the manufacture of lac-dye in India the red liquor obtained from washing stick-lac is first of all strained through some textile fabric, in order to remove all portions of woody matter and other foreign substances. "It is then," to quote once more from Prof. Ball, "poured into large vats, where it is allowed to settle; the sediment is subjected to various washings, and at last allowed to settle finally, the supernatant liquor being drawn off. The sediment, when it is of the proper consistency, is placed in presses, from which it is taken out in the form of hard, dark, purple cakes, with the manufacturer's trade-mark impressed upon them. By the addition of mordants, this dark purple substance yields the most brilliant scarlet dyes, which are not inferior, I believe, to those produced by cochineal itself."

Of greater repute and of more importance than lac-dye is cochineal, which is the source of artists' carmine and carmine-lake, while when precipitated with a salt of tin, it also yields a splendid scarlet. The cochineal insect, of which the female, like that of the nearly allied lac-insect, alone yields the dye, is originally a native of Mexico, where it is parasitic on the leaves of the prickly-pear. The males of the *Coccus cacti*, as the species is called, are minute insects furnished with well-developed wings, feathered antennæ, and a long pair of hair-like processes at the hinder extremity of the body. On the other hand, the female is a repulsive-looking wingless creature, with very short posterior hairs, and nearly double the size of her partner. These insects adhere tightly to the smooth surface of the fleshy leaves of the prickly-pear; and are not unlike small purple wood-lice in general appearance.

The following account of the cochineal-harvest is extracted from the English edition of Figuier's "Insect World." "These insects are collected when the females are about to lay, that is, when a few young are hatched. It is when the females are pregnant that they contain the greatest amount of coloring matter. When the harvest-time has arrived, the cultivators stretch out on the ground pieces of linen at the foot of the plants, and detach the cochineals from them, brushing the plants with a rather hard brush, or scraping them off with a blunt knife. If the season be favorable, the operation may be repeated three times in the course of the year in the same plantation. The insects thus collected are killed by dipping into boiling water, by being put into an oven, or by being placed on a plate of hot iron. When withdrawn from the boiling water they are placed on strainers in an airy position, first in the sun, and afterward in the shade. During their immersion they lose the white powder with which they are covered in life. In this state they are called *ronagridas* by the Mexicans. Those that have passed through the oven they term *jaspeadas;* these are ashy gray in color, but those which have been placed on the hot plate become blackened, and are hence called *negras*. In commerce three sets of cochineal are recognized; first, the *mastique*, of a reddish color, with a more or less abundant glaucous powder; secondly, the *noir*, which is large, and blackish brown in color; and, thirdly, the *sylvestre*, which is smaller and of a reddish color. The last description, which is gathered from wild cacti, is the most highly esteemed of all. Each year there are imported into France 200,000 kilogrammes of cochineal insects, which represent a value of about three million francs."

The cochineal trade is chiefly in the hands of the Spanish and the French. By the latter government these insects have been successfully introduced into Algeria, where they yield a large revenue. About the middle of the last century the government were accustomed to purchase the entire harvest at the rate of fifteen francs the kilogramme. At a still earlier date they were introduced into the Canaries, where they have also become well established; but the attempts to acclimatize them in Corsica and the south of France resulted in failure.

In the early days of civilization, long before America was dreamed of, carmine was furnished by two European insects belonging to the family *Coccidæ*. The first of these is *Cermes vermilio*, the kokkos of the ancient Greeks, and the kermes or alkermes of the Arabs and Persians. The females of this species are found adhering to the twigs of the kermes oak (*Quercus coccifera*), which grows in dry districts throughout most of the Mediterranean countries of Europe. On their native oaks the insects form dry brittle masses, which were (and perhaps still are) collected by the peasants in the south of France. When separated and completely dried, they are known as *graines de kermes*. In appearance they may be likened to purple currants; and when subjected to suitable treatment they yield a splendid red dye.

The second species is the Polish kermes (*Porphyrophyra polonica*), which once attained great celebrity under the name of the scarlet grains of Poland. The females of this insect frequent in great numbers the roots of a plant belonging to the genus *Scleranthus*, and are common in many parts of Poland and Germany, as well as in other districts of Central Europe. Toward the end of June the bodies of the females become greatly distended with a purple fluid; and it was at this time of the year that they were formerly collected in great numbers for the dyer. Now, however, they are superseded in commerce by cochineal and lac, although it is probable that their product is still employed to a certain extent locally.

An animal dye that has completely disappeared from use is the celebrated Tyrian purple of the ancients. Whether the dye, as originally manufactured, really had the splendid tint accorded to it by tradition, is unfortunately now impossible to determine. This dye is yielded by the common dog-winkle (*Purpura lapillus*), and may best be obtained by crushing the shell carefully and extracting the fluid from a white vein situated near the head. When first applied to linen this fluid makes a green stain, which if exposed to sunshine gradually changes to deep purple red. If the linen be washed with soap in hot water a further change to bright crimson will take place, this being permanent, without the aid of any mordant. Owing to the mixture of mucus with the pigment, linen dyed with it has always a blotched appearance; but whether the ancients had means of making the color spread uniformly is not known. A purple dye may also be obtained from the posthorn pond-snail (*Planorbis corneus*.

The dark pigment sepia, which consists of the dried contents of the ink-bag of various cuttle-fish and squids, is on the other hand, an article of considerable value. It was formerly used as a writing fluid, and appears to have been employed in painting by the Chinese from time immemorial. Some years ago it was stated that the *sepia* of the water-color artist was made of lampblack; but although that substance may be employed for cheap imitations, the genuine article is still the product of the cuttle-fish and squid. Large quantities of the dried ink-bags of these mollusks are received by artists' colormen for manufacture into sepia. And some firms regularly send their agents among the fishermen on our southern coasts for the purpose of collecting the ink-bags. These are saved by the fishermen when cutting up squids and cuttles for bait; and it has been suggested that the Newfoundland fishermen, who annually destroy a large number of these mollusks, might make a considerable revenue by saving and selling their ink-bags.

* "Jungle Life in India," p. 308 (1880).

ORIGIN OF THE FINS OF FISHES.

ONE of the most interesting problems in vertebrate morphology, and one of the most important from its wide-reaching relations, is that of the derivation of the fins of fishes. This resolves itself at once into two problems, the origin of the median fins, which appear in the lancelets, at the very bottom of the fish-like series, and the origin of the paired fins or limbs, which are much more complex, and which first appear with the primitive sharks.

In the process of development the median or vertical fins are doubtless older than the paired fins or limbs, whatever be the origin of the latter. They arise in a dermal keel which is developed in a web fitting and accentuating the undulatory motion of the body. In the embryo of the fish the continuous vertical fin from the head along the back and around the tail precedes any trace of the paired fins.

In this elementary fin-fold elementary supports, the rudiments of fin-rays, tend to appear at intervals. These are called ray-hairs. They are the prototype of fin-rays in the embryo fish, and doubtless similarly preceded the latter in geological time. In the development of fishes the caudal fin becomes more and more the seat of propulsion. The fin-rays are strengthened, and their basal supports are more and more specialized.

That the vertical fins, dorsal, anal, and caudal, have their origin in the median fold of the skin admits of no very serious question. In the lowest forms which bear fins these structures are dermal folds, being supported by very feeble rays. Doubtless at first the vertical fins formed a continuous fold extending around the tail, this fold ultimately broken by atrophy into distinct dorsal, anal, and caudal fins. In the lower fishes, as in the earlier sharks, there is an approach to this condition of primitive continuity, and in the embryos of almost all fishes the same condition occurs.

The question of the origin of the paired fins is much more difficult and is still far from settled, although the majority of recent writers have favored the theory that these are parts of a once continuous lateral fold of skin corresponding to the vertical fold which forms the dorsal, anal, and caudal. In this view the lateral fold is soon atrophied in the middle, while at either end it is highly specialized, at first into an organ of direction, then into fan-shaped and later paddle-shaped organs of locomotion. Finally, from the jointed paddle, which Gegenbaur has called the archipterygium, there has developed, on the one hand, the rayed pectoral and ventral fins of ordinary fishes, and on the other, in land-creeping animals, jointed legs and arms. As to this the evidence of paleontology is conflicting.

An early shark of the Devonian, *Cladoselache*, has fan-shaped paired fins so formed and placed. Another shark almost as old, *Pleuracanthus*, of the carboniferous, has fins which fit best a totally different theory of origin. Its jointed or archipterygial fin has no resemblance to a fold of skin, but accords better with Gegenbaur's theory that the pectoral limb was at first a modified septum or gill arch. Sharks still older than either (*Heterodontidæ*) in the Silurian, so far as we can judge by their teeth, are closely related to forms bearing the more specialized type of fin found in the typical sharks of to-day. Evidently none of these three, as seen in the rocks, represents the real beginning of paired fins in the life of the past.—David Starr Jordan in Popular Science Monthly.

AMERICAN PHOTOGRAPHIC EXHIBIT AT TURIN.

AMERICAN pictorial photography won another triumph recently at the Turin Exposition in a most gratifying and unexpected way. The New York Camera Club had been invited to participate in the Turin International Decorative and Fine Arts Exposition, but had failed to take action in the matter. Two months before the exposition opened Mr. Alfred Stieglitz made some efforts to gather a number of pictures from some of his friends, and also drew on his own collection. Altogether he succeeded in preparing an exhibit of sixty photographs, the work of about thirty men. After the close of the exposition Mr. Stieglitz was awarded the special prize of his Majesty the King of Italy—a valuable piece of bronze—for the best collection in the exposition. Not content with this mark of distinction, individual exhibitors were given two gold medals, four silver medals, and eight honorable mentions.

SMALL-SCALE APPARATUS FOR FOUCAULT'S PENDULUM EXPERIMENT.

THE repetition at the Pantheon, Paris, of Foucault's classical pendulum experiment has raised the question whether it is not possible to demonstrate the earth's rotation by means of a pendulum of modest dimensions. As a matter of fact, Foucault himself had furnished the answer to this question, for before setting up his full-scale pendulum at the Pantheon, he had put up at his own residence a pendulum of two meters (6 feet 6 inches) length, whose oscillations, at the end of some fifteen minutes, showed a noticeable displacement from the apparent plane of original oscillation.

Small-scale apparatus for the repetition of this experiment would be appreciated by many, and more particularly by teachers and students. Now M. Cannevel, a young engineer, has furnished this in the form of a small cabinet 2½ inches by 6 inches by 8 inches, containing a full set of apparatus required for the experiment. The cabinet also contains a small frame from which a little pendulum is suspended.

This frame, which is shown on the left in our illustration, serves to show experimentally the principle upon which Foucault's proof of the earth's rotation depends. A swing is imparted to the bob of the little pendulum suspended from the frame. On then moving the frame about gently, it is found that the plane of oscillation of the pendulum remains parallel to itself, although the point of suspension is displaced. It is then readily seen that in general if the earth rotates, the plane of vibration of the pendulum will appear to shift with regard to the earth. Conversely, if the earth were at rest, the plane of oscillation of the pendulum must appear unchanged. Experiment shows that the former is the case.

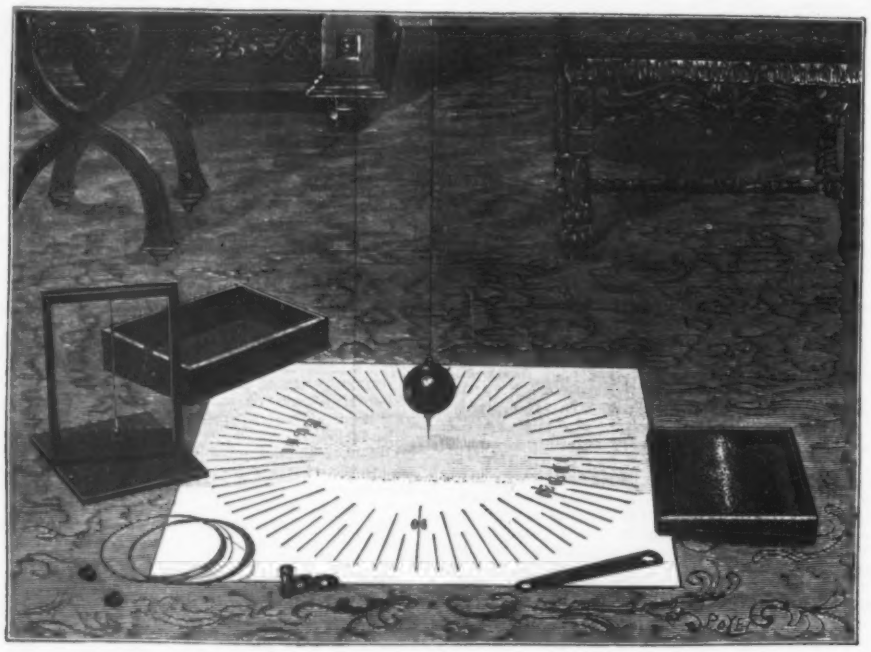
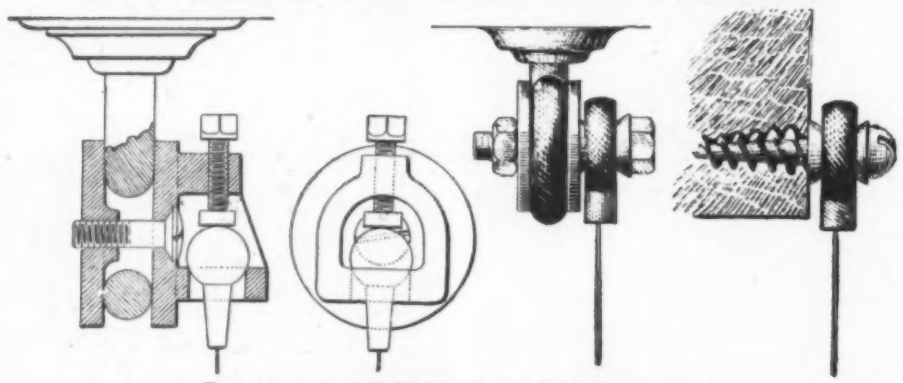


FIG. 1.—APPARATUS FOR DEMONSTRATING THE EARTH'S MOTION.



FIGS. 2 AND 3.—SUSPENSION OF THE PENDULUM.

With M. Cannevel's pendulum a graduated dial placed under the bob as in the figure indicates a displacement of 11.294 deg. per hour for the latitude of Paris. After 15 minutes a pendulum of 2.50 meters will already show a deviation of 2 cm. if its initial amplitude were 75 cm.

The cabinet contains all the parts required to perform Foucault's experiment: one lead ball cased in brass and weighing 2½ pounds, a quantity of sand, the dial for measuring the displacement—50 cm. in diameter—nuts, bolts, a spanner, piano strings 0.35 mm. in diameter for suspending the bob, and two suspending clutches. The suspending device, which in this experiment is of great importance, consists of a metal ring with an opening of 0.32 mm. into which the wire of 0.35 mm. diameter is forced. The suspending device is shown in our last figure.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

AN EXPERIMENT TO DETERMINE THE MECHANICAL EQUIVALENT OF HEAT.

AT the recent meeting of the Physical Society of London, Prof. H. L. Callendar exhibited a "Lecture Experiment for the Determination of the Mechanical Equivalent of Heat." According to the Mechanical Engineer, the experiment was carried out with a modified form of the apparatus exhibited and described by Prof. Callendar at the meeting of the Physical Society held on June 20, 1902.

In the original apparatus conduction from the calorimeter was prevented by ebonite bushes and the stability of the motion was secured by using a compound belt of silk and leather. In the new pattern the calorimeter is much lighter, and is fastened to driving cheeks by steel bolts and ivory distance pieces. The increased conduction loss is compensated by the diminished air loss. Owing to the chemical action of leather on brass, the original belt was removed and a belt of double and single silk ribbon substituted. A small spring balance has been introduced to secure stability, and the difference of the weights at the ends of the belt can be read to an accuracy of one part in 4,000. In the actual experiment performed at the meeting, Count Rumford's compensation method was adopted to eliminate the errors arising from loss of heat by radiation and conduction, the calorimeter being half filled with water at a suitable temperature less than that of the laboratory. The calorimeter was then made to revolve on a horizontal axis by means of an electric motor, and the air temperature was determined with a platinum thermometer fixed near to the instrument. The experiment was performed by observing the temperature of the water in the calorimeter at a certain instant, and again after every successive 100 revolutions up to 600. The air temperature was then redetermined, and the mean air temperature during the experiment calculated. The interval selected for the calculation of J was from the first reading of the temperature of the calorimeter until the time when the mean temperature of the calorimeter throughout the experiment was the same as the mean temperature of the air. The initial and final air temperatures were 19.07 and 19.40, giving a mean of 19.24. The temperature of the water in the calorimeter at the commencement of the observation was 16.17, after 500 revolutions it was 21.59, and after 600 revolutions 22.59. By interpolation it was found that the mean temperature of the calorimeter throughout the experiment was, after 558 revolutions, the same as the mean air temperature. The rise of temperature was found to be 6.00, and the value of J deduced from the experiment was 4.22 joules per calorie.

THE COCK OF THE CATHEDRAL OF STRASBURG.

AT the Grande Taverne de Coq d'Or, at Paris, may be seen the chanticleer, which is an imitation of the ancient cock on the clock of the cathedral of Strasburg (1352—1789). This mechanical piece contains a combination of levers working automatically, but only from 11 o'clock in the morning to 3 o'clock in the morning. The remainder of the time the levers remain in repose, but the motive train may be put in action at any moment. Every time that the clock strikes, the cock shakes his wings three times, raises his head, and opening his beak, launches out a very successful *ki-kiri-ki*. The original of this curious automaton is at Strasburg, in one of the halls of the building of L'Œuvre Notre-Dame, an annex of the cathedral, where it is carefully preserved, among the other souvenirs of past ages.

Sad stories have been related of the astronomical clock by different authors, which recent and thorough researches have reduced to their just value; thus, Bishop Conrad de Lichtenberg has been accused of putting out the eyes of one of the brothers Habrecht, a clockmaker of Schaffhausen, who had carried out the plans of the celebrated mathematical professor Rauhfus, named *Dasipodius*. Habrecht had, they say, violated his oath to not reproduce his work. Now, it is absolutely established that Habrecht underwent no punishment of this or any other kind, and that the famous tradition is a pure fiction.

The mechanism consists of four essential parts: (1) the pendulum, which gives the time on a small external dial, and which releases the motive train after each hour; (2) the motive train, connected with the weight, which communicates to the head, the tail, and the wings of the cock their various movements; (3) the bellows producing the chant; and (4) the cock, with his various articulations, to which the movements are given by means of two iron wires passing to the interior of the legs.

When the motive train is set going, the wings of the cock are first raised three times by means of a lever connected with the iron wire passing to one of the legs. The movements of the head and tail are produced by an eccentric disk acting on a second lever in communication with the wire passing to the other leg. During this time a second eccentric disk has raised the bellows, and also a weight, which at a given moment falls with all its force on a lever. This lever acts on the bellows, and thus produces the strident cry of the cock; the modulation of the crowing is effected in an original manner, by which great distinctness is secured for the different sounds; one of the sides of the bellows carries a rack, which actuates a pinion fixed on the other side of the bellows; on the arbor of this pinion is a disk; this has on its circumference notches in which a lever acting on the escape valve can engage. Each notch corresponding to an opening of the valve, the sounds are produced in conformity with the notches made in the disk. The weight which acts on the bellows is so arranged as to lose its force by degrees toward the end of the cry, so that this diminishes and gradually dies out.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from the Revue Chronometrique.

THE USE OF CAMELS IN AFRICA.

AT the present day camels are used for all sorts of domestic purposes in Africa. They may even be seen drawing plows in the interior of the Regency of Tunis. You may remark a woman and a camel harnessed to the same plow, and you hesitate to decide which is the greater outrage. They are also used for drawing water from the strange, cumbersome, old-fashioned wells of North Africa.

Their chief use, however, is for caravans. You may behold them bringing in huge cases of dates from the oases, or you may see them with great tent-like structures of red silk upon their backs. These tents are for the conveyance of Arab women of the upper classes, who seek to maintain the privacy of the harem even on a journey. Two women and some children are often accommodated on one camel. They have cushions on which they can lie down, and even sleep. It is stuffy, and it is dark, but they deem themselves well off in escaping from the searching rays of the burning sun.—Pearson's Magazine.

CHARLEMAGNE'S BURIAL-PLACE.

THE perennial controversy over the exhumation of Charlemagne has revived of late in Germany. It is one of the most desperate of its class. We are accustomed to read, as a simple matter of fact, that the Emperor Otho III. resolved to test the value of tradition which asserted that Charlemagne sat in a chair of state beneath the altar of the Church of the Holy Virgin at Aix la Chapelle. In the year 1000 he carried out his purpose. A manuscript almost contemporary gives an account of the operation in the very words, as it professes, of Count Otho of Lourello, Captain of the Imperial Guard, who was present. They cut through an "alcove" by the altar, and found the great King, exactly as legend described him, upright on his throne, the crown upon his head, and the scepter in his hand, a gold chain round his neck. A snow-white beard covered his chest, and the nails had grown through his gloves. So well had he been embalmed that only the tip of his nose was decayed, and Otho replaced this with gold, removed the crown, sword, and other valuables, also one of the teeth; draped the figure in white, and rebuilt the alcove. The story could not be more circumstantial, and it is told by an eye-witness, apparently. Further, the crown and sword are preserved to this day at Vienna, and no one has ever questioned their authenticity. There was a "talisman" also, which Otho bestowed upon the city; the city presented it 800 years afterward to Napoleon, who gave it to the Earl of Holland. His representative restored it to Napoleon III., and it is now at the Louvre. Upon the whole, the evidence seems indisputable. But on the other hand we have the positive statement of Eginhard and Thegan, his friends and ministers, that Charlemagne was buried on the day he died. They say nothing of embalmment. It seems very improbable that the science in those days could have preserved the flesh of a man who died of dropsy; certainly it could not have done the work in a few hours. Had it not been for this picturesque story, no one would have questioned that Eginhard's description refers to a simple burial beneath the pavement of the church. But there is another objection. No "alcove" can be found which shows signs of disturbance, and, though the pavement has been tested again and again, no vault can be discovered. Further, the Chronicle of Cologne reports, under the date 1165, that Frederick Barbarossa "lifted the bones of Charlemagne out of the sarcophagus in which they had lain for 261 years." Apparently they had not heard at Cologne of Otho's remarkable discoveries. A sarcophagus is still shown to visitors, but, to complete the confusion, it is far too small to

have held the giant. The crown and sword and the rest have still to be accounted for. But it is recorded that when the Danes were advancing on Aix in 880 the treasures of the church were removed to Stablo. It seems more than likely that any valuables in Charlemagne's grave would be sent away with them.—London Standard.

THE AIRSHIP SYSTEM OF M. FREDERICK L'HOSTE.*

By DR. T. BYARD COLLINS.

IN the airship system proposed by M. L'Hoste the balloon itself is of novel construction. It is of cylinder conical shape and encircled by three hoops which support a tubular steel axis running through the center of the balloon from end to end. The hoops are

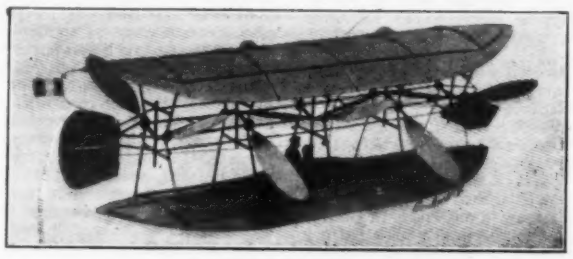


FIG. 2.—A MODEL OF THE AIRSHIP.

of wood and are joined to the center pieces by wire stays, much as the rim of a bicycle wheel is joined to its hub. It therefore possesses very considerable rigidity, and is held in shape, not as other dirigible balloons, by the internal pressure of the contained gas, but by the nature and form of the framework.

Two pulleys are attached to the axis, one on either side of the center, and upon these, by means of ropes, are hung two small compensating balloons, each independently in contact with the outside air and capable of being raised or lowered as demanded by the balloon's exigencies at any moment.

By this form of structure M. L'Hoste hopes greatly to augment the elements of economy and safety. First, the absence of interior pressure thus secured reduces the leakage of gas through the pores of the envelope to a minimum—a leakage which has hitherto been a source both of waste and danger. Second, the absence of internal pressure precludes the possibility of the balloon's bursting from this cause, as was the case of Severo's "La Paix," dropping him to a horrible death two thousand feet below. And finally, in case of accidental deflation, the balloon, maintaining its form, would in its descent present an immense surface to the opposition of the atmosphere, thus acting as a parachute and effectually breaking the force of the fall.

The forward end of the balloon is covered by a kind of pneumatic cap formed of silk and sewed on the cone. This cover, which when distended gives the prow a favorable form for the reduction of atmospheric resistance to forward propulsion, and also increases the rigidity of that portion of the aerostat most needing such a character, is filled with gas to a point of pressure superior to that of the atmosphere; but this is the only part of the balloon in which such pressure obtains, and if this inflated end cover should burst, the balloon would suffer no vital damage.

The inventor has also given the question of equilibrium and stability careful attention. Aft of the balloon is a silken rudder hinged to the end of the axis, and spread out like a bird's tail. To this rudder is attached a rigid rod which runs beneath the body of the balloon and terminates in a weight directly beneath the center of the long axis. This weight, acting as a pendulum, automatically raises and lowers the

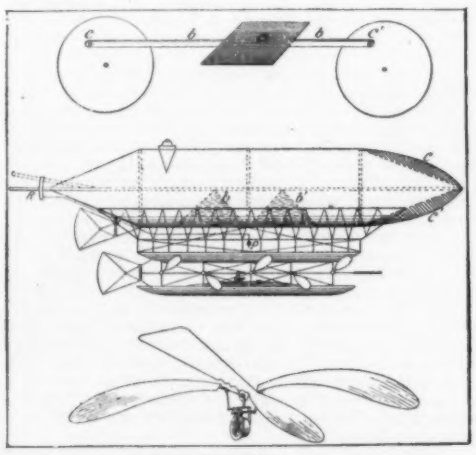


FIG. 1.

1.—a, plane horizontal surface; b, rod; c c, cranks.
2.—Diagram of L'Hoste's Airship System. b b', two small compensating balloons; c c', pneumatic cap; R, horizontal rudder giving stability and equilibrium; the pendulum attachment is shown at P.
3.—Diagram of one of Hargrave's Flying Models, showing the trochoidal movement of the wings.

rudder relative to the angle which the balloon may tend to assume at any moment, thus keeping the craft constantly on an even keel. There is also a vertical sail aft which is operated in the usual way.

Below the balloon is suspended the car, a photograph of which is presented herewith. It will be seen that M. L'Hoste seeks to utilize not only the lifting power of a gas bag, but also the advantages both of the aeroplane and of beating wings.

The framework of the structure is of Mannesmann steel tubing of small diameter. The top and bottom support concavo-convex aluminium aeroplanes. In the machine now building these planes are 12 meters long by 4 meters wide and 9 meters long by 3 meters wide respectively, the upper one being the larger.

To the fore and midway between the planes is a horizontal rudder, and aft a vertical one, both plainly appearing in the photograph. But the most remarkable part of M. L'Hoste's invention consists in the propellers.

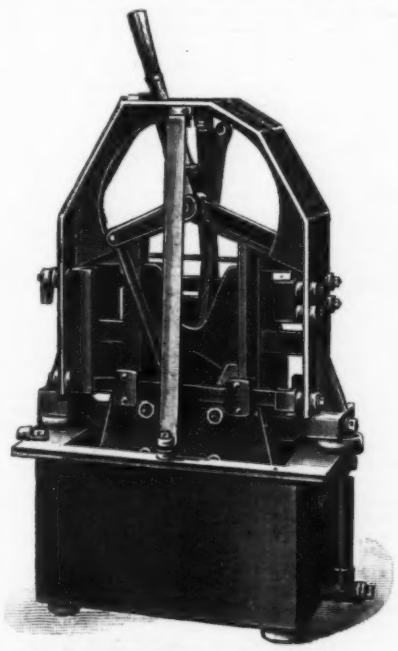
In 1893 the late Mr. Hastings argued learnedly before the International Conference on Aerial Navigation that the screw was vastly more efficient as a propeller than anything else could possibly be. But Mr. Hargrave, who had had large experience in the construction of flying models, had found that beating wings for both vertical and horizontal propulsion were quite as efficient as the screw. Several years before Mr. Hargrave read a paper before the Royal Society of N. S. W., in which he defined the trochoided plane as "a flat surface, the center of which moves at a uniform speed in a circle; the plane being kept normal to the surface of a trochoidal wave, etc." A trochoided plane is illustrated in Diagram 1, where a plane horizontal surface *a* is rigidly attached to the rod *b* connecting the crank *c c'*. By imagining these cranks to revolve, carrying the connecting rod with its attachment around with them, one may get a very clear conception of a trochoided plane. Mr. Hargrave, in the paper above referred to, then proceeded to show that "the trochoided plane is the mechanical power almost universally used by nature for the transmission of force." And then, after giving many illustrations, he continued: "The trochoidal action of fins, muscles, and legs seemed so plain that I could not help theorizing on the action of wings in flight; . . . the chain of evidence seemed so complete that I have no doubt it will soon be accomplished without the aid of the screw or gas bag. . . . There is a distinction between the vertical lift we see when a bird rises straight up, as exemplified by skylarks, hawks, and partridges, and the horizontal flight of ducks, pelicans, and albatrosses. In the first place, the wing, which is in effect a plane, is rotated in a cone and kept normal to a trochoid during each revolution. . . . In horizontal flight the conical movement is the same, but the connecting rod is at right angles to the plane of the wings, and flight is the resultant of gravity and the waves of air being thrust downward and backward by the wings."

Now this is the principle sought to be utilized by M. L'Hoste in his propellers, of which there are five pairs, as shown in the photograph of the model presented herewith. They are made of aluminium on a light steel framework, and so constructed that the forward edge is rigid while the posterior portion is flexible. Each wing terminates at its inner end in a kind of handle which passes through the ball socketed in the framework, the ball acting as a fulcrum upon which the wing may be moved in any direction. The inner ends of the handles are then joined to a series of connecting rods, thus revolving the wings in a cone and causing them to act as modified trochoided planes; the alternate pairs having a reciprocating motion, and, being rigid only on their forward edges, change their angle of incidence at each vibration. On the down stroke the angle is such that a forward thrust results; on the up stroke the inclination is reversed, so that a forward thrust again results. It is thus that M. L'Hoste would obviate the necessity for the use of the time-honored screw.

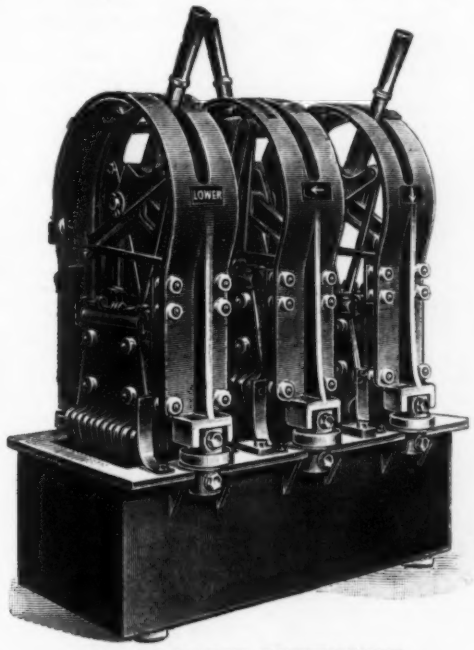
The machinery is to be actuated by two forty horse power petroleum motors of exceptional lightness and placed in the hold of the vessel, as shown in the photograph.

With the French, the weight of powerful motors for aeronautical purposes is no longer so serious a consideration as formerly, since having made such progress of late they are now dreaming of inclosing a horse power within the compass of a watch case.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



SINGLE MOTOR CONTROLLER.



THREE MOTOR CONTROLLER.

SOME ELECTRICAL SWITCHES.

A NUMBER of improvements in electrical switches have been introduced by Messrs. Dorman & Smith, of Manchester. We recently had an opportunity of inspecting a number of these at the firm's Ordsal Station Electrical Works, Salford. One is a liquid motor-controller specially designed for working the motors on overhead electrical cranes. The accompanying illustrations, one of a switch for controlling three motors, and the other for controlling a single mtor, show clearly the effective, but at the same time simple, arrangement of this switch. A solution of caustic potash is used for the liquid. The contact between the source of supply and the motor is made by lowering a cast iron plate into the solution. When this plate only just touches the solution the resistance is naturally considerable, but it is of course reduced as the area of the immersed part of the plate increases. These switches are each fitted with a reversing switch. In order to simplify the gearing, two plates are used in each switch, one for the go-ahead and one for the go-astern, or lower and lift, as the case may be. By this method, as will be seen from the illustrations, a simple form of gearing, which lends itself neatly to the reversing switch arrangement, is all that is required. The whole of the electrical connections are insulated from the iron framework, and the tank itself is generally unearthed.

Another switch we saw was an edgewise grip contact switch. In this switch the blades are gripped on to the contacts by means of a toggle arrangement, which is operated by a continued motion of the switch handle after the switch blades have reached their position on the contacts. On opening the circuit the first movement operates the toggle, and so reduces the pressure on the contacts; at the same time a trigger is lifted and the switch arm flies off, moving over the contacts with a light rubbing pressure.

The main circuit-breaking switch is combined with an auxiliary switch interlocked so that the main switch is closed first, then the circuit is completed through the auxiliary switch, leaving the main switch quite free to be opened by any automatic device. This auxiliary switch cannot be opened until after the main switch has been opened. The automatic device on the overhead or maximum switches presents several novel features. It is claimed to insure absence of friction immediately the armature has started to move.—The Engineer.

To Clean a Panama Hat which has become stained by perspiration, the National Druggist recommends the following process: Apply first sodium hypophosphite in strong solution, liberally. The best plan is to immerse the hat in the solution, and shortly afterward immerse it in one of oxalic acid. After the stain has disappeared, which it will do in the course of an hour or two, rinse the hat in clear water first, and afterward in water carrying a little glycerin. Then let it dry, and send it to the hatter to be blocked. The object of the second rinsing is simply to make the hat supple. The writer hereof has treated his own hat, which he has worn for several years, in this manner several times, and it is yet a passable one. Of course, it was a good one in the first place or it would not have stood the treatment.

A FINAL DECISION IN THE BERLINER PATENT CASE.

ONE of the most important decisions which has yet been handed down in the protracted telephone litigation with which patent lawyers, as well as inventors, are more or less familiar, was rendered January 16, 1903, in the United States Circuit Court of Appeals. The case was that of the American Bell Telephone Company against the National Telephone Manufacturing Company; the patent at issue was that granted to Emile Berliner November 17, 1901, covering a battery telephone transmitter of the variable resistance type.

A battery transmitter is one in which a battery or strong current is utilized for the transmission of speech, as distinguished from a magneto transmitter, in which only a feeble current is generated by induction. It requires a battery current to transmit speech long distances. The variable-resistance type of transmitter utilizes a battery current for the transmission of speech by varying the electrical resistance in the circuit. Variable resistance means simply variable obstruction to the passage of the current. Variable resistance changes the strength or intensity of the current, and if these changes correspond to the changes in the density of the air caused by sound-waves, we have a current whose electrical undulations or vibrations are similar in form to sonorous vibrations or sound-waves, and which will transmit speech. In a telephone transmitter variable resistance refers to the changes in resistance which take place at the contact between the two conductors or electrodes, produced by the vibrations of the diaphragm caused by the sound-waves.

The Berliner transmitter covered by his patent in suit, utilizes a battery current for the transmission of speech by varying the electrical resistance in the circuit.

The Berliner transmitter consists of a battery circuit with two electrodes in constant contact. One electrode is composed of a diaphragm or plate of metal or other vibratory material, and the other electrode of a metallic ball or point. Sound uttered against the diaphragm causes it to vibrate. These vibrations vary the pressure between the electrodes at the point of contact so as to strengthen and weaken the contact, and thereby vary the electrical resistance of the circuit.

The claims in issue were the following:

"1. The method of producing in a circuit electrical undulations similar in form to sound-waves by causing the sound-waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

"2. An electric speaking-telephone transmitter operated by sound-waves and consisting of a plate sensitive to said sound-waves, electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate."

These claims must be read in connection with the disclaimer of the patent, which declares that the patentee does not claim to be "the first inventor of the art of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the sound-waves accompanying said sounds," nor to be "the first who caused such electrical undulations by varying the resistance of an electric circuit in which a current was passing."

In view of this disclaimer the first claim, the court found, covers only the particular method described, for varying the resistance in the circuit to produce electrical undulations, similar in form to sound-waves; and the second claim covers only an instrument or transmitter which embodies this method. The invention covered by claim 1 was first disclosed by Berliner in a caveat dated April 14, 1877. This method of varying the resistance in the circuit by varying the pressure at the point of contact between solid electrodes in constant contact is the same as that disclosed by Prof. Hughes on May 9, 1878, in a paper read before the Royal Society of London. Prof. Hughes christened his instrument the microphone. The complainant claimed that Emile Berliner was the original and first inventor of the microphone, which position was necessary in order to make out infringement. In the defendant's transmitter carbon electrodes were used; and unless Berliner has discovered and disclosed the microphonic method of varying resistance, his patent must be limited to the metallic electrodes described in his specification, thereby freeing the defendants of the charge of infringement.

The speech-transmitting telephone presents the problem of the reproduction, by means of an electric current, of a succession of vibrations on the receiving diaphragm which shall exactly correspond to the vibrations of the transmitting diaphragm caused by the air vibrations, or sound-waves, produced by the voice in speaking. The problem was rendered more difficult for the reason that the air vibrations caused by the vocal organs in articulate speech are very complex in form.

On March 7, 1876, a little more than a year before the Berliner caveat appeared, Bell's basic patent was issued, disclosing his art of transmitting speech by creating changes of intensity in a continuous current of electricity exactly corresponding to changes of density in the air caused by the vibrations which accompany vocal sounds. This is known as Bell's undulatory current, which simply means an electric current whose undulations are similar in form to sound-waves.

The prior current in the Reis telephone would only reproduce musical tones. It would not reproduce the finer and more complex sonorous vibrations upon which depends the quality of sound which characterizes the human voice. This was because the current was intermittent. Bell discovered that the current must be continuous in order to impress upon it changes which correspond to the form of sound-waves.

The Bell patent also disclosed several ways of utilizing his undulatory current. One way is known as the magneto method, in which the current is induced or generated from the magnetic field surrounding an electro-magnet by the movements of the diaphragm caused by sound-waves. These movements, by altering the condition of the magnetic field, produce a current which corresponds in form to the sound-waves. An undulatory current of this kind, generated by the transmitter itself by means of the slight movements of the diaphragm, is necessarily feeble, and can transmit speech only short distances. Nevertheless, this instrument was the first practical speech transmitter, and the only commercial transmitter in use, until it was supplanted by the carbon variable-resistance transmitter.

Berliner subsequently took out a patent for an improved form of transmitter, in which the diaphragm itself was of metal instead of being a membrane with an attached armature. Another way of utilizing Bell's undulatory current disclosed in his 1876 patent was by varying the resistance of a battery circuit.

The art, as it was left by Bell's primary patent, may be thus summarized: There existed the undulatory current, the only known current which will transmit speech. There existed one form of its application, known as the magneto transmitter or magneto telephone, which went into extensive use for several years, but which would transmit speech only a short distance, owing to the feebleness of the current. There existed also another way of utilizing the undulatory current by varying the resistance in a battery circuit at the contact between electrodes in constant contact, those electrodes being a solid and a liquid. The instrument embodying this method is known as the mercury transmitter.

After these disclosures in the Bell patent, the problem which remained was the invention of a practical transmitter which would utilize the undulatory current by varying the resistance in a battery circuit, and so transmit speech long distances. Bell had supplied the current, and had shown that it could be utilized by varying the resistance in a battery circuit; and what remained was to devise a better way of varying the resistance than was pointed out by Bell. This problem was solved by two discoveries which are now embodied in every commercial transmitter. The first was the discovery of the peculiar properties of carbon in varying electrical resistance, and the second was the discovery of the remarkable effects of sound-waves in varying resistance at a loose contact between solid electrodes. Edison made the first discovery, and the fundamental question for determination in this case was whether Berliner or Hughes first made the second discovery. The instrument which utilizes both these discoveries is called a microphone transmitter. Every microphone transmitter, as commonly understood in the telephonic art, is an instrument having carbon electrodes in loose or feeble contact. But a transmitter may still be a microphone without having carbon electrodes, provided the electrodes are of solid material, and so capable of embodying microphonic action. It is not pretended that Berliner discovered the carbon electrode, but it is maintained that he was the first to discover microphonic action, and to embody that principle in an operative speech transmitter.

Before considering the microphonic method, and Berliner's priority of invention over Hughes, the court briefly traced the development of the variable-resistance transmitter.

After Bell's great contribution to the telephonic art in 1876, the thoughts and efforts of inventors were largely turned in the direction of material and structure rather than to the discovery of new methods. The only two transmitters then known which used a battery current were the Reis transmitter and the Bell mercury transmitter; and inventors naturally looked for the solution of the variable-resistance transmitter problem along the lines of these instruments.

The Reis transmitter employed a battery current. There was a diaphragm set in motion by sound-waves, and there were two metallic electrodes in loose inconstant contact in the circuit. This instrument would transmit musical sounds, but not articulate speech, because at every full vibration of the diaphragm the electrodes separated, thereby interrupting the current. In structure this instrument was substantially like the Berliner transmitter. Reis failed because he had not discovered that a continuous current, which requires a constant contact between the electrodes, was essential to transmit speech. In spite of this failure, it has been truly said that the telephonic art owes much to Reis.

The next battery instrument was Bell's mercury transmitter, described in his 1876 patent, in connection with his undulatory current. This instrument was operative, but not practical.

In February, 1877, eleven months after Bell's patent disclosed his mercury transmitter, Edison invented what is known as the plumbago-film transmitter. This instrument utilized Bell's undulatory current in a battery circuit by varying the resistance between solid electrodes in constant contact. It was an operative instrument, but not practical.

In this instrument we have a diaphragm set in motion by sound-waves, and two solid electrodes in constant contact. The vibrations of the diaphragm due to the sound-waves caused it to come into greater or less contact with the disk, and so varied the resistance in the circuit. The thin film of plumbago on the disk being a poorer conductor than the metal diaphragm, the movements of the diaphragm cut in and out the resistance of the circuit.

The way or method of varying the resistance in this transmitter would seem to be by varying the extent or area of contact surface between the electrodes caused by the vibrations of the diaphragm, although the patent also speaks of the vibrations as causing an increase and decrease of electric energy according "to the intimacy of contact between the vibrating diaphragm and the surface of the adjacent disk."

Next comes Edison's plumbago cylinder transmitter of April 1, 1877. This instrument also utilized Bell's undulatory current in a battery circuit by varying the resistance between solid electrodes in a constant contact. It was an operative speech transmitter, but not practical.

Next in order of time is the Berliner transmitter described in the caveat of 1877. This instrument also utilizes Bell's undulatory current in a battery circuit by varying the resistance between solid electrodes in constant contact. It was an operative speech transmitter, but it never went into use.

In this instrument we have a diaphragm set in motion by sound-waves, and two metallic electrodes in constant contact. The vibrations of the diaphragm vary the pressure at the point of contact, and thereby vary the resistance in the circuit. The way or method of varying the resistance in this transmitter is by varying the pressure at the point of contact, and so varying the intimacy of contact between the electrodes. When the electrodes in this instrument are so adjusted as to be in loose contact we have present microphonic action, and the instrument becomes a microphonic transmitter. It may be here observed, however, that the court was not concerned with the inquiry whether the Berliner instrument became a microphone when properly adjusted, but whether Berliner first discovered the microphonic way of varying resistance, and made it known to the world in his caveat.

Next comes Edison's carbon transmitter which was invented in the fall of 1877, and is described in his patent dated April 30, 1878. The instrument utilizes Bell's undulatory current in a battery circuit by varying the resistance between two solid electrodes, one of which is carbon.

"The vibrations of the diaphragm," in the words of the patent, "subject the carbon to different pressures, according to the amplitude of motion resulting from the sound-waves, and this difference of pressure varies the resistance offered by the carbon to the passage of the current, and produces a rise and fall of electric tension." The way or method of varying the resistance in this transmitter is by varying the pressure at the contact and so varying the intimacy of contact between two solid electrodes. In this instrument Edison disclosed to the world his discovery of the special properties of carbon in varying resistance in a telephone transmitter. When the electrodes in this instrument are adjusted in feeble contact it becomes a microphone.

The Edison carbon transmitter was the first practical long-distance speech-transmitter which utilized Bell's undulatory current in a battery circuit by varying the resistance in the circuit. The commercial art passed at once from Bell's magneto transmitter to Edison's carbon transmitter. In December, 1879, there were 34,000 magneto transmitters in use, and 18,000 variable-resistance carbon transmitters. Subsequently, the use of the magneto transmitters declined, and they were supplanted by the carbon transmitter. All variable-resistance transmitters commercially used have carbon electrodes in loose contact. The alleged infringing transmitters in the case at bar are mere improvements in the structure, form or adjustment of the Edison carbon transmitter, invented by him in the fall of 1877.

In coming to the crucial point on which the complainant rested his claim, the court stated the position of the complainant in the following terms:

Berliner first discovered the microphonic method of varying resistance, and first disclosed this method, and an operative instrument embodying it, in his caveat of April 14, 1877. In other words Berliner first invented the microphone. Bell's mercury transmitter and Edison's plumbago film and plumbago cylinder transmitters are not anticipations, because they do not operate by the microphonic method. They are not microphones. On the other hand, Edison's carbon transmitter and the two carbon transmitters made or used by the defendants infringe the Berliner patent, because they employ the microphonic method, and are microphones. The microphonic method is not limited to the use of the carbon electrode, but only to the use of solid electrodes, or hard and unyielding electrodes, and therefore the carbon electrode, when there is microphonic action, is within the microphonic method, and infringes the Berliner patent. The microphonic method was disclosed to the scientific world by Prof. Hughes in May, 1878, and was regarded as a wonderful discovery.

Hughes called his instrument a microphone, from analogy to the microscope, since he believed it would magnify small sounds. The microphonic method of varying resistance, disclosed by Hughes in 1878, was the same as the microphonic method of varying resistance disclosed by the Berliner caveat in 1877. To be sure, the Hughes instrument, which he was the first to term a microphone, was constructed of carbon electrodes, but this is immaterial, because he states that the best material for the electrodes has not yet been discovered, and because his discovery resides in the method of varying the resistance, and not in the materials composing the electrodes.

The Berliner invention consists in the method of varying the resistance by the variation of pressure at the point or points of contact between electrodes in constant contact. To determine whether this invention is the same as the Hughes method of varying resistance, the court thought it necessary to give a clear explanation of the nature of the discovery which he revealed on May 9, 1878.

The introduction of the telephone led Prof. Hughes to investigate the effect of sonorous vibrations upon the electrical behavior of matter. Sir William Thomson and others have shown that resistance to the passage of currents afforded by wires is affected by their being placed under strain, and, inasmuch as the conveyance of sonorous vibrations induced rapid variations in the strain at different points of a wire, Prof. Hughes believed that the wire would vary in its resistance when it was used to convey sound. To investigate this he made a rough telephone receiver or "sound detector," which he connected in line with a battery current in a closed circuit. The apparatus or materials experimented upon were used in the same way as the transmitter of the speaking telephone of Bell.

Prof. Hughes had discovered microphonic action, a mode of operation of the instrument which he called the microphone. By a process of deduction and experiment he made his great discovery of the effects of sonorous vibrations in varying the electrical resistance at a feeble or loose contact between two electrodes. Prof. Hughes discovered a new way of varying resistance which has proved of great utility in the telephonic art. Unless anticipated by Berliner, he was the first to disclose this new way, although previously it may have been present in telephone transmitters without the knowledge of the inventors. Prof. Hughes' discovery lay to loose initial contact between the electrodes. This is the essence of the microphone. With loose initial contact there is microphonic action; without loose initial contact there is no efficient microphonic action. When the contact between the electrodes is greater or less than a feeble contact, such action is either greatly impaired, or ceases altogether. Microphonic action, or the microphonic method, or the microphonic process or art, discovered by Prof. Hughes, is simply the effects of sonorous vibrations in varying resistance at a feeble or loose contact between solid electrodes in constant contact, whereby sound is reproduced at the receiver. Microphonic action is dependent upon three simple conditions, atmospheric vibrations produced by sound-waves, two solid electrodes in feeble contact in a line circuit, and a sound-receiving instrument in the circuit. What produces these effects is unknown. Prof. Hughes believed the effects were "due to a difference of pressure at the different points of contact," and that they were "dependent for the perfection of action upon the number of these points of contact." Prof. Bell doubted this, and attributed the effects to "a variation in the amount of contact" supplemented by the heat produced at the point of contact. But what causes these effects is immaterial. What we know is that the phenomenon exists, and was disclosed by Prof. Hughes.

The court thought it was impossible to find in the Berliner caveat or patent any conception of Hughes' discovery, and that Berliner had not advanced so far in his conception of microphonic action as Hughes. Keeping in mind that microphonic action influences the conception of sonorous vibration and loose contact between electrodes, the court analyzed Berliner's conception and invention. Berliner's conception of a telephone transmitter was this:

Starting with the electrodes in contact, he conceived that a varying pressure between the points of contact, and a consequent varying of the strength of the current, could be obtained by the vibration of one or both of the electrodes caused by sound-waves. This conception does not reach to the character of the initial contact, and therefore does not even approach microphonic action.

If Prof. Hughes had embodied his conception in a telephone transmitter he would have made an invention, in that he had discovered that the minute atmospheric vibrations due to sound-waves would sometimes so vary the pressure between the points of contact of metallic electrodes as to strengthen and weaken the current, and so reproduce sound. And this is exactly the scope of the Berliner conception, and of his invention. His conception, by reason of the absence of any comprehension of microphonic action, when embodied in a transmitter, produces an instrument which is sometimes operative and sometimes not. If, by accident, the electrodes are adjusted in loose initial contact, or microphonic contact, the instrument may be operative, while, if not so adjusted, it is inoperative.

But while Prof. Hughes, under such circumstances, would have made an invention, he could not have seriously asserted that he had discovered microphonic action, because when he placed the ends of the wire in contact, he had not made his discovery, and that it was only after repeated experiments with all degrees of contact pressure he found the ends must be placed in loose contact to insure the reproduction of sound.

Contact, or points of contact, are meaningless as a conception of microphonic action. So, likewise, is the conception of varying pressure at the contact or points of contact. A contact, or points of contact, affected by varying pressure, may be a firm contact, in which case there is no microphonic action, or a very loose contact, in which case there is no microphonic action, or any other degree of contact where microphonic action is not present. Microphonic action resides in the conception of a loose initial contact between the electrodes, and it is immaterial to this conception how the sound-waves affect such a contact, whether by varying pressure or not. This shows that it is only the clear comprehension of loose contact which can be held to be a conception of microphonic action. A conception of microphonic action which omits loose contact leaves out the very essence of the thing to be conceived.

On April 30, 1877, 16 days after the filing of the caveat in suit, Berliner filed another caveat, which describes an ingenious arrangement for "producing sound by the noise of sparks." On May 9, 1877, nine days afterward, Berliner filed a third caveat for what is known as his double-pin instrument. This was for an improvement on the ordinary make-and-break transmitter, by the use of a double contact. Then follows, on June 4, 1877, the application for the patent in suit, covering, with the receiver, single-pin transmitters and double-pin transmitters, continuous currents and intermittent currents, in such a confused way that an intelligent and satisfactory interpretation of this document bids defiance to the human understanding. The obscurity of the paper may be in part accounted for by the blunders of the solicitor's clerk, but not wholly; for it is quite manifest that Berliner's ideas at this time as to the best form of transmitter, and the principle of its operation, were unsettled and needed clarification. This course of action on the part of Berliner may not be conclusive of anything. It is sometimes unsafe to infer too much from a subsequent line of conduct. In this particular case, however, the court thought this much may be said with truth:

Assuming that Berliner, on April 14, 1877, had already made Hughes' discovery of microphonic action, his caveat of May 9 and his application of June 4 become incomprehensible.

In this connection it may be noticed that, in his two patents for microphones, No. 222,652 and No. 224,573, applied for more than two years after his caveat, and more than a year after the publication of the Hughes article, Berliner describes the necessity of loose initial contact between the electrodes. In the first instance, one of the electrodes, which is preferably of carbon, is described as "just in contact by its own weight with said plate," and in the claim as "the said non-elastic pin resting solely by its own weight upon the diaphragm." The second patent is for maintaining the carbon pin constantly in light contact with the diaphragm "by the action of gravity," or, in the words of Claim 1, "an opposite electrode maintained in contact with the vibrating surface by the action of gravity." Here is the loose initial contact of Hughes, and the maintenance of such a contact during the operation of the instrument.

Berliner's attempts to make his transmitter reproduce speech were hardly satisfactory; but, as the evidence stands, he succeeded in reproducing some words, and indistinct sentences, so that it may be said there was the transmission of the quality of sound which characterizes the human voice in speaking. In his experiments with the instrument he says nothing about loose contact between the electrodes, or the necessity of such contact. That his efforts were not more successful he believes was owing to the crudeness of the apparatus and the difficulty of adjusting it. His apparatus, however, was not more crude than the apparatus which Hughes used in his experiments. The unsatisfactory character of Berliner's efforts cannot be wholly ascribed to this cause, nor to the fact that he used metallic electrodes, which, for several reasons, are difficult properly to adjust, nor to both of these causes combined, but must have been due, at least to some extent, to his ignorance of microphonic action. Had he known of Hughes' discovery, the results, in all probability, would have been much more satisfactory. Subsequent experiments, however, have shown that the Berliner instrument can be so adjusted as to become an operative speech transmitter. But the experts who made these experiments years afterward had been long familiar with Hughes' disclosure of microphonic action, and they knew the absolute necessity of loose initial contact between the electrodes in order to make the instrument an operative speech transmitter. They certainly possessed this advantage over Berliner, and the success of their efforts may be attributed in part to this cause.

The complainant's contention that Hughes' discovery of microphonic action is disclosed in the Berliner caveat rests upon general definitions of the microphone and of Berliner's invention rather than upon a critical analysis of the actual discovery revealed by Hughes in his article, or a critical examination of the Berliner caveat.

The definition of the Berliner invention is founded on what the complainant conceived to be the "true definition of the microphone," which is as follows:

"The essence of the microphone consists in varying the resistance at the 'joint' or point of contact between two electrodes by varying the pressure between them."

But this is not descriptive of the microphone, or of microphonic action, as disclosed by Hughes. "A joint" may be either tight or loose, and a "point of contact" may be either firm or feeble, and the difference between a joint and a loose joint, and a point of contact and a feeble point of contact, is the difference between what is a microphone and what is not a microphone.

Again, the Berliner invention is defined as "varying the pressure at a point of contact between electrodes," or "varying the pressure between two electrodes in contact and thereby varying the resistance in the circuit so as to produce undulatory sound-waves." More fully stated, the definition may be expressed as follows: The method of varying resistance by variation of pressure at the point of contact between solid electrodes in constant contact. These definitions are not descriptive of the microphone or of microphonic action, because they omit any reference to loose contact between the electrodes.

In comparing the Berliner and Hughes inventions, it will also be observed that no mention is made of loose contact, or feeble contact, or light contact, and that, consequently, all of these descriptions are wanting in any reference to the essence of microphonic action. What Hughes disclosed to the world, as we have seen, was not varying the pressure at the point of contact; nor did the essential thing which he discovered lie in the difference of pressure at different points of contact. His discovery resided in loose contact, or rather in the remarkable effects of sonorous vibrations in varying resistance at a loose contact. He also made loose contact between the electrodes the indispensable feature of his microphone. In describing that instrument in his article, he says: "The form of the lozenge-shaped carbon is not of importance, provided the weight of this upright contact piece is only just sufficient to make a feeble contact by its own weight." He believed that these effects were due to pressure at the points of contact. This, however, was simply his theory of what took place, his theory of microphonic action. Except in alluding to this theory near the close, the word "pressure," throughout the article, has reference to initial contact pressure. "Variation of pressure at a point of contact" may be descriptive of Berliner's invention, but, to say the least, it is a mistaken and misleading description of microphonic action and of Prof. Hughes' discovery.

Again, the first and most important claim of the Berliner patent fails to define the microphonic method of Hughes. The claim is for "the method of producing in a circuit electrical undulations, similar in form to sound-waves, by causing the sound-waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit." It will be observed that the claim is silent as to the character of the initial contact between the electrodes. The claim must be read as if written April 14, 1877, a year before the Hughes discovery. With such knowledge of the telephonic art as existed at that time, no one would have known from this description of the Berliner method that the electrodes must be adjusted in a loose initial contact. In omitting any reference to loose contact, the claim fails to disclose the essence of the Hughes microphonic method.

The complainant rested its case on the prior discovery by Berliner of microphonic action as disclosed by Prof. Hughes in his article of May 9, 1878. We are of the opinion that Berliner had no conception of this discovery, that he does not disclose such discovery in his caveat or patent, and that if his transmitter operated as a microphone, it did so without any knowledge on his part of the microphonic principle. The world was left in the same ignorance of microphonic action after the appearance of his caveat as before. If Prof. Hughes had had lying on his table a Berliner transmitter and the Berliner caveat, they would have revealed nothing to him, nor have been of any assistance in the experiments which resulted in his discovery of the remarkable effects of sound-waves in varying electrical resistance of a loose or feeble contact. If he had taken the diaphragm and metal ball of the Berliner instrument in place of the ends of his wire, he must have gone on experimenting with the effect of sonorous vibrations at different degrees of initial pressure between the plate and ball, until he had discovered that only with a slight pressure, or feeble contact, is there microphonic action. Prof. Hughes' discovery cannot be read into the Berliner caveat or the claims of the Berliner patent.

In connection with the invention set forth in the Berliner caveat, the complainant's experts dwell on "transition resistance," and the fact that such resistance varies enormously with pressure. "Transition resistance" is only another name for loose-contact resistance, or microphonic resistance, and it was Hughes, not Berliner, who discovered transition resistance in the telephonic art, and the effects of sound-waves in varying such resistance.

Summarizing its conclusions, the court said:

"We find that Bell, in March, 1876, discovered that the minute atmospheric vibrations due to sound-waves would cause the diaphragm to vibrate, which vibrations, by varying the pressure between a solid electrode and a liquid electrode in constant contact, produced variations of electrical resistance, whereby speech may be transmitted.

"We find that Edison, in February, 1877, discovered that the minute atmospheric vibrations due to sound-waves would cause the diaphragm to vibrate, which vibrations, by varying the pressure between two solid electrodes of different conductivity in constant contact, one metallic and the other hard rubber covered with a plumbago film, produced variations of electrical resistance, whereby speech may be transmitted.

"We find that Edison, on April 1, 1877, discovered that the minute atmospheric vibrations due to sound-waves would cause the diaphragm to vibrate, which vibrations, by varying the pressure between two solid electrodes in constant contact, one metallic and the other compressible plumbago, produced variations of electrical resistance, whereby speech may be transmitted.

"We find that Berliner, on April 14, 1877, discovered that the minute atmospheric vibrations due to sound-waves would cause the diaphragm to vibrate, which vibrations, by varying the pressure at the point of contact between metallic electrodes in constant contact, produced variations of electrical resistance, whereby speech may be transmitted.

"All of these discoveries, when embodied in transmitters, were inventions, but none of them was a commercial instrument, or solved the problem of a practical long-distance speech transmitter.

"We find that, in the fall of 1877, Edison discovered the carbon electrode; that this discovery represents the first marked advance in the transmitter art since the 1876 Bell patent; and that the carbon electrode is found in every commercial battery transmitter.

"We find that in May, 1878, Prof. Hughes discovered microphonic action, or the fact that sound-waves produce remarkable variations of resistance at a loose or feeble contact between solid electrodes in constant contact, whereby speech may be transmitted; that the principle he then made known is utilized in every practical battery transmitter; and that he embodied his discovery in an instrument, which he was the first to term a microphone.

"We also find that Edison's discovery of the carbon electrode and Hughes' discovery of microphonic action solved the problem of a variable-resistance transmitter, whereby speech may be transmitted long distances; and that both these discoveries are embodied in the defendants' transmitters.

"We also find that the two claims of the Berliner patent in suit, although upon their face open to the objection of excessive breadth, may be sustained when read in connection with the specification, provided they are limited to metallic electrodes, and that, when so limited, the defendants' transmitters do not infringe.

"Our conclusion is that the decree of the Circuit Court must be affirmed on the ground of non-infringement."

The Mouth Barometer.—A few years ago P. Gruetzner described a simple and cheap barometer, on Hooke's principle, which has since been used for Alpine expeditions. It utilizes the expansion and contraction of air under a diminution or increase of pressure. If the temperature is constant the volume of air is inversely proportional to the pressure. In the author's apparatus the constant temperature is obtained by putting the bulb into the observer's mouth. The temperature of the human mouth is 36.7 deg. C., or 307 deg. absolute, and does not vary, as a rule by more than 1 per cent. It is therefore practically constant. The bulb of the mouth barometer is partly filled with colored paraffin which is driven into a tube provided with a scale, and serves to indicate the volume of air in the bulb. The author now quotes a number of observations made with a mouth barometer and an aneroid, in which the maximum error of the former is 3 mm. The mouth barometer has probably no advantage over the pocket aneroid, except its extremely low price.—P. Gruetzner, Ann. der Physik, No. 9, 1902.

AMBULANCE WORK IN COUNTRY DISTRICTS OF GERMANY.

GREAT advances have been made in Germany within the last couple of decades in the system of ambulance and first aid to the sick and injured. The movement was set on foot years ago by Esmarch, who, on his approaching eightieth birthday will be able to look back with deep satisfaction upon the rich harvest which the seed sown by him is bringing. Esmarch early recognized the necessity of spreading among the general population some familiarity with the *rationale* and methods of ambulance work by supplying the necessary information in suitable terms. For in the absence of such knowledge the patient afflicted is liable to have his troubles increased by the injudicious handling he receives from those who are anxious to help him.

Cities and the densely populated centers of industry were naturally the first to receive attention. For here, owing to the frequency of accidents, the need was felt most strongly, and here the remedy was comparatively ready of supply. For a time the country districts were left entirely out of the account. Yet peculiar difficulties are attached to any endeavors to bring aid to the injured in the country, and call for special efforts to meet wants which in the city are easily supplied. The great distances and consequent difficulty in obtaining immediate medical care and proper material for treatment and transport, tend to expose the patient to such extreme discomfort and suffering that the need of systematic help is felt very urgently indeed.

The "Landes Samariterverband" (State Ambulance Association), of the Kingdom of Saxony has made it a special object to introduce the necessary improvements to provide efficient means of allaying the sufferings and giving the necessary aid to inhabitants of rural districts who are unfortunate enough to meet with an accident. Much energy and good judgment have been shown in the carrying out of this enterprise, which was financed by the government of Saxony. The latter had long realized the need of improvement in the ambulance service of the country.

The association struck out in three directions, to obtain the desired aid. In the first place, it has striven to improve the means and methods of transport for the peculiar conditions of rural ambulance work. Secondly, it has prepared and distributed chests containing suitable bandages for first aid to various injuries. These chests have been fitted according to the instructions of experienced surgeons, and supply all the articles requisite for present-day surgical treatment. But their particular value lies in a plan which has been adopted to insure that none of the bandage material inclosed shall under any circumstances become unfit for use, and have to be rejected, as has been liable to happen with the usual modes of packing it. The third object toward which the association has worked is the establishment of loan stations from which articles for the care of the sick can be obtained.

In addition to these precautions, care has been taken that in all those places where the means for assistance are supplied, there are also left in charge persons familiar with the use and preservation of the materials. Such persons were supplied chiefly from ambulance corps and similar bodies, but also from fire brigades, rural police, etc.

Our illustrations depict some of the improved accessories used by the association. Their construction was determined by the experience of specialists and the test of practical usage combined. It is evident that good results in such a matter are much more likely to be obtained if the stock of experience collected over a large area is worked up from a central board than if each small district were left to work out its own system. Just in the case of ambulance work, a great deal of waste has been occasioned by the neglect of this fact. At the same time, due regard was paid to the special needs of each locality; thus in some places it was deemed necessary to have in readiness a covered van drawn by a horse, while in others a stretcher supported on wheels and pushed by hand was regarded as sufficient.

The most important demands made on an efficient system of ambulance are: Simple and convenient working of the appliances; complete security of the patient; smooth and easy spring mechanism of the stretcher; and last but not least, possibility of thorough disinfection. With the usual mode of transport in the country, the danger of infection is very considerable. All these conditions are perfectly satisfied by the ambulance carriage, the interior of which is shown in our first illustration. The injured person is laid upon the stretcher, the footboard of which is seen on the left-hand side of the van. In case of need, a second patient can be accommodated upon the bench on the right, which when not in use can be folded back against the wall of the van. There is then still room left for the attendant, whose seat also folds against the wall near the door at the back of the van. The breadth of the track of the van is sufficiently narrow to allow it to pass upon country lanes. The interior is airy and light, allowing of a close observation of the patient by the attendant at all times, and of perfect ventilation by the windows in the walls of the van. The internal covering of the van is carefully packed in the joints; the walls are impregnated and polished smooth, are not attacked by moisture, and present no edges or corners. It is therefore easy to thoroughly clean and disinfect the interior. Under the driver's box are carried the chest of bandages, and a number of covers.

In addition to protection against jolts afforded by the ordinary carriage springs the patient is further shielded by the construction of the stretcher itself, which is shown in Fig. 2. The method of supporting the stretcher in the van from below was resorted to in preference to that suspending it, as the latter requires for its manipulation several strong hands trained to the work; and also because the horizontal motion of a suspended stretcher during the journey can never be wholly eliminated even by the most careful fastenings. It will be seen in the figure that the stretcher rests on four small wheels with thick rubber tires, which are connected with the main part of the stretcher by two pairs of good springs. This affords an exceedingly elastic and soft support and the stretcher easily glides into the van under the hand of quite an inexperienced operator. The handles are made to slide in under the stretcher when the latter is placed in the van, and when in this position they fit with their rubber-tipped ends against the front and back walls of the van, holding the stretcher securely in position. The mattress of the stretcher is covered with rubber cloth, which can be removed and thoroughly cleaned.

For short distances the model shown in Figs. 3 and 4 is used. The sailcloth awning protects the patient from wind and rain and shuts off the gaze of the inquisitive. As it is removable, it does not inconvenience the bearers in passing through narrow passages of a building, and does not unnecessarily add to the weight of the stretcher indoors. The top can be thrown back near the head, thus admitting light and air at discretion. In this case also the mattress is covered with rubber cloth which can be taken off for cleaning. The stretcher weighs 40 pounds, the awning 22 pounds, and the carriage 123 pounds. The springs are carefully chosen and the whole is solidly made.

In one of the figures there is also visible a chest of bandages, such as the association supplies for ambulance work in country districts. Each bandage is packed separately, as is absolutely necessary for ambulance work. Each individual package contains all the articles necessary for bandaging the particular injury it is calculated for: gauze, cottonwood, bandage—all sterilized and inclosed in a paper or cardboard cover. The inscriptions upon the cover, such as finger, limb, head bandages, etc., are easily understood by a lay worker. But above all this arrangement prevents half-used bandages and other material from being put back into the chest, which would soon render the further use of the chest unsafe.—Translated for the SCIENTIFIC AMERICAN from Illustrirte Zeitung.

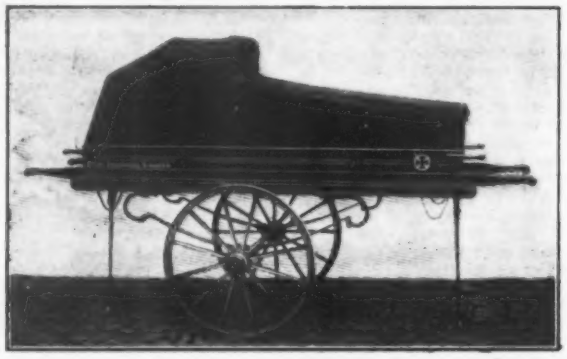


FIG. 4.—AMBULANCE STRETCHER WITH SAILCLOTH COVERING.

FIG. 1.—AMBULANCE WAGON. VIEW OF INTERIOR COMPARTMENT.

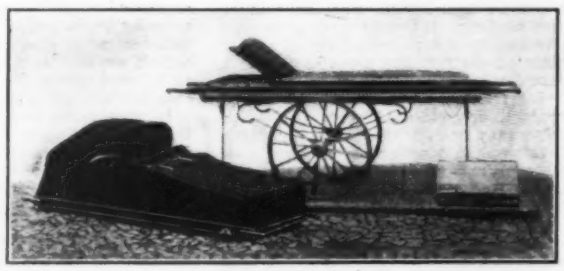


FIG. 3.—AMBULANCE STRETCHER MOUNTED UPON CARRIAGE, SHOWING REMOVABLE COVER AND CHEST OF BANDAGES.

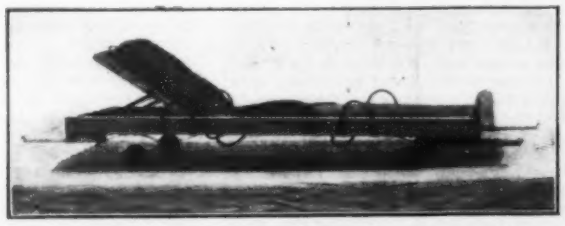


FIG. 2.—THE STRETCHER SUPPORTED ON SPRINGS.

PERFUME PLANTS OF INDIA.

INDIAN GARDENING says: "The manufacture of perfumes in India is an industry which probably dates back to 'the dim ages of the past,' for the native of India dearly loves perfumes. His tastes, however, are not those of the European, and Indian scents do not commend themselves to Europeans, for the reason that they are 'heavy' in the sense that they are not volatile; indeed, the effects of Indian perfumes are generally overpowering to the European olfactories, and that is one reason why they are not popular with us. Moreover, the Indian method of extracting the perfume from flowers is peculiar, being always in oils. They have no idea of 'essences' such as are manufactured by European perfumers. One reason for the 'heaviness' of Indian perfumes is found in the vehicle employed, which is sandalwood oil. This oil is not, strictly speaking, sandalwood oil, but the common 'sweet' or 'ginjelly' oil employed as a vehicle for extracting the perfume from sandalwood, and it is this oil that forms the basis of all Indian perfumes, and which accounts for the 'heaviness' referred to above. The Indian perfumer has not yet arrived at the stage of assimilating Western methods of perfume manufacture; when he does, the perfume industry of India will become one of the most important in the country. That this country possesses hundreds of perfume-yielding plants is undoubted, and we shall here enumerate a few of the best known. Of course, the several jessamines (chamell, motea, mogra, and jhooee are the native names of these) are in great favor with Indians. Next comes the champa (michelia champaca); the rose (gulab) takes third place. Keora (pandanus arboratissimus) is also a great favorite. The well-known khus-khus (andropogon muricatus) yields an oil much prized by natives; another grass oil is obtained from agia-ghass (andropogon citralus and a. nardus). The foregoing may be regarded as the principal plants depended upon for the manufacture of Indian perfumes. There are, of course, hundreds—nay thousands—of shrubs and trees in this country yielding highly-scented flowers, which could be utilized for perfume manufacture, and were a good firm to open a manufactory in India, an extraordinary impetus would be given to the perfume industry of this land. One has only to cast a cursory glance over the great wealth of material ready to hand to realize this. To name only a few: Acacia farnesiana, artabotrys odoratissimus, cananga odorata, plumeiria acuminata and alba, mesua ferrea, aglaia odorata, mimusops elengi,

pergularia odoratissima, polyanthus tuberosa, the several albizzias, the common sirris, the several magnolias and some ixoras, the great orange tribe, cæsalpinia coriaria, clerodendron fragrans, gardenias, hedychimus, hamiltonias, murraya exotica, nyctanthes arbortristes, lansonia alba, jonesia asoka, hoyas, dombeya acutangular, and a host of others. All the foregoing are common plants, capable of being grown on a large scale if a demand was created for their flowers. Here we have not taken account of plants remarkable for the fragrance of their leaves or roots, such as lemonia spectabilis and hamalomena aromatica, for example. Looking at the question from a purely trade aspect, it appears to us that a great chance is open to some enterprising European firm to take advantage of, and develop a thriving and money-making business."

THE FIRE WALK CEREMONY IN TAHITI.*

By S. P. LANGLEY.

THE very remarkable description of the fire walk collected by Mr. Andrew Lang and others had aroused a curiosity in me to witness the original ceremony, which I have lately been able to gratify in a visit to Tahiti.

Among these notable accounts is one by Col. Gudgeon, British resident at Raratonga, describing the experiment by a man from Raiatea, and also a like account of the Fiji fire ceremony from Dr. T. M. Hocken, whose article is also quoted in Mr. Lang's paper on the "Fire Walk," in the Proceedings of the Society for Psychical Research, February, 1900. This extraordinary rite is also described by Mr. Fraser in the Golden Bough, and by others.

I had heard that it was performed in Tahiti in 1897, and several persons there assured me of their having seen it, and one of them of his having walked through the fire himself under the guidance of the priest, Papa-Ita, who is said to be one of the last remnants of a certain order of the priesthood of Raiatea, and who had also performed the rite at the island of Hawaii some time in the present year, of which circumstantial newspaper accounts were given, agreeing in all essential particulars with those in the accounts already cited. According to these, a pit was dug in which large stones were heated red-hot by a fire which had been burning many hours. The upper stones were pushed away just before the ceremony, so as to leave the lower stones to tread upon, and over these "glowing red-hot" (according to the newspaper accounts), Papa-Ita had walked with naked feet, exciting such enthusiasm that he was treated with great consideration by the whites, and by the natives as a god. I found it commonly believed in Tahiti that anyone who chose to walk after him, European or native, could do so in safety, secure in the magic which he exercises, if his instructions were exactly followed. Here in Tahiti, where he had "walked" four years before, it was generally believed among the natives, and even among the Europeans present who had seen the ceremony, that if anyone turned around to look back he immediately was burned, and I was told that all those who followed him through the fire were expected not to turn until they had reached the other side in safety, when he again entered the fire and led them back by the path by which he had come. I was further told by several who had tried it that the heat was not felt upon the feet, and that when shoes were worn the soles were not burned (for those who followed the priest's directions), but it was added by all that much heat was felt about the head.

Such absolutely extraordinary accounts of the performance had been given to me by respectable eye-witnesses and sharers in the trial, confirming those given in Hawaii, and, in the main, the cases cited by Mr. Lang, that I could not doubt that if all these were verified by my own observation, it would mean nothing less to me than a departure from the customary order of nature and something very well worth seeing indeed.

I was glad, therefore, to meet personally the priest, Papa-Ita. He is the finest-looking native that I have seen; tall, dignified in bearing, with unusually intelligent features. I learned from him that he would perform the ceremony on Wednesday, July 17, the day before the sailing of our ship. I was ready to provide the cost of the fire, if he could not obtain it otherwise, but this proved to be unnecessary.

Papa-Ita himself spoke no English, and I conversed with him briefly through an interpreter. He said that he walked over the hot stones without danger by virtue of spells which he was able to utter and by the aid of a goddess (or devil as my interpreter had it), who was formerly a native of the islands. The spells, he said, were something which he could teach another. I was told by others that there was a still older priest in the island of Raiatea, whose disciple he was, although he had pupils of his own, and that he could "send his spirit" to Raiatea to secure the permission of his senior priest if necessary.

In answer to my inquiry as to what preparations he was going to make for the rite in the two or three days before it, he said he was going to pass them in prayer.

The place selected for the ceremony fortunately was not far from the ship. I went there at noon and found that a large shallow pit or trench had been dug, about 9 by 21 feet and about 2 feet deep. Lying nearby was a pile containing some cords of rough wood, and a pile of rounded water-worn stones, weighing, I should think, from 40 to 80 pounds apiece. They were, perhaps, 200 in number, and all of porous basalt, a feature the importance of which will be seen later. The wood was placed in the trench, the fire was lighted and the stones heaped on it, as I was told, directly after I left, or at about 12 o'clock.

At 4 P. M. I went over again and found the preparations very nearly complete. The fire had been burning for nearly four hours. The outer stones touched the ground only at the edges of the pile, where they did not burn my hand, but as they approached the center the stones were heaped up into a mound three or four layers deep, at which point the lowest layers seen between the upper ones were visibly red-hot. That these latter were, nevertheless, sending out considerable heat there could be no question, though the topmost stones were certainly not red-hot, while those at the bottom were visibly so and were occasionally splitting with loud reports, while the flames from the burned wood near the center of the pile passed up in visible lambent tongues, both circumstances contributing to the effect upon the excited bystanders.

The upper stones, I repeat, even where the topmost were presently removed, did not show any glow to the eye, but were unquestionably very hot and certainly looked unsafe for naked feet. Native feet, however, are not like European ones, and Mr. Richardson, the chief engineer of the ship, mentioned that he had himself seen elsewhere natives standing unconcerned with naked feet on the cover of pipes conveying steam at about 300 deg. F., where no European foot could even lightly rest for a minute. The stones then were hot. The crucial question was, How hot was the upper part of this upper layer on which the feet were to rest an instant in passing? I could think of no ready thermometric method that could give an absolutely trustworthy answer, but I could possibly determine on the spot the thermal equivalent of one of the hottest stones trodden on. (It was subsequently shown that the stone might be much cooler at one part than another.) Most obviously, even this was not an easy thing to do in the circumstances, but I decided to try to get at least a trustworthy approximation. By the aid of Chief Engineer Richardson, who attended with a stoker and one of the quartermasters, kindly detailed at my request by the ship's master, Capt. Lawless, I prepared for the rough but conclusive experiment presently described.

It was now nearly forty minutes after 4, when six acolytes (natives), wearing crowns of flowers, wreathed with garlands and bearing poles nearly 15 feet long, ostensibly to be used as levers in toppling over the upper stones, appeared. They were supposed to need such long poles because of the distance at which they must stand on account of the heat radiated from the pile, but I had walked close beside it a moment before and satisfied myself that I could have manipulated the stones with a lever of one-third the length, with some discomfort, but with entire safety. Some of the uppermost stones only were turned over, leaving a superior layer, the long poles being needlessly thrust down between the stones to the bottom, where two of them caught fire at their extremities, adding very much to the impression that the exposed layer of stones was red-hot, when in fact they were not, at least to the eye. These long poles and the way they were handled were, then, a part of the ingenious "staging" of the whole spectacle.

Now the most impressive part of the ceremony began. Papa-Ita, tall, dignified, flower-crowned, and dressed with garlands of flowers, appeared with naked feet and with a large bush of "ti" leaves in his hands, and after going partly around the fire each way, uttering what seemed to be commands to it, went back, and, beating the stones nearest him three times with the ti leaves, advanced steadily, but with obviously hurried step, directly over the central ridge of the pile. Two disciples, similarly dressed, followed him,

THE FIRE WALK CEREMONY IN TAHITI.

* Reprinted from Nature in the Smithsonian Report,

but they had not the courage to do so directly along the heated center. They followed about halfway between the center and the edge, where the stones were manifestly cooler, since I had satisfied myself that they could be touched lightly with the hand. Papa-Ita then turned and led the way back, this time with deliberate confidence, followed on his return by several new disciples, most of them not keeping exactly in the steps of the leader, but obviously seeking cooler places. A third and fourth time Papa-Ita crossed with a larger following, after which many Europeans present walked over the stones without reference to the priest's instructions. The natives were mostly in their bare feet. One wore stockings. No European attempted to walk in bare feet, except in one case—that of a boy, who, I was told, found the stones too hot and immediately stepped back.

The *mise en scène* was certainly noteworthy. The site near the great ocean breaking on the barrier reefs, the excited crowd talking about the "red-hot" stones, the actual sight of the hierophant and his acolytes making the passage along the ridge where the occasional tongues of flame were seen at the center, with all the attendant circumstances, made up a scene in no way lacking in interest. Still, the essential question as to the actual heat of these stones had not yet been answered, and after the fourth passage I secured Papa-Ita's permission to remove from the middle of the pile one stone, which, from its size and position, every foot had rested upon in crossing and which was undoubtedly at least as hot as any one of those trodden on. It was pulled out by my assistants with difficulty, as it proved to be larger than I had expected, it being of ovoid shape, with the lower end in the hottest part of the fire. I had brought over the largest wooden bucket which the ship had and which was half filled with water, expecting that this would cover the stone, but it proved to be hardly enough. The stone caused the water to rise nearly to the top of the bucket, and it was thrown into such violent ebullition that a great deal of it boiled over and escaped weighing. The stone was an exceedingly bad conductor of heat, for it continued to boil the water for about twelve minutes, when, the ebullition being nearly over, it was removed to the ship and the amount of evaporated water measured.

Meanwhile others, as I have said, began to walk over the stones without any reference to the ceremony prescribed by Papa-Ita, and three or four persons, whom I personally knew on board the ship, did so in shoes, the soles of which were not burned at all. One of the gentlemen, however, who crossed over with unburned shoes, showed me that the ends of his trousers had been burnt by the flames which leaped up between the stones, and which at all times added so much to the impressiveness of the spectacle; and there was no doubt that anyone who stumbled or got a foot caught between the hot stones might have been badly burned. United States Deputy Consul Ducorran, who was present, remarked to me that he knew that Papa-Ita had failed on a neighboring island, with stones of a marble-like quality, and he offered to test the heat of these basaltic ones by seeing how long he could remain on the hottest part of the pile, and he stood there, in my sight, from eight to ten seconds before he felt the heat through the thin soles of his shoes beginning to be unpleasantly warm.

A gentleman present asked Papa-Ita why he did not give an exhibit that would be convincing by placing his foot, even for a few seconds, between two of the red-hot stones which could be seen glowing at the bottom of the pile, to which Papa-Ita replied with dignity, "My fathers did not tell me to do it that way." I asked him if he would hold one of the smaller upper hot stones in his hand. He promised to do so, but he did not do it.

The outer barriers were now removed and a crowd of natives pressed in. I, who was taking these notes on the spot, left, after assuring myself that the stones around the edge of the pit were comparatively cold, although the center was no doubt very hot, and those below red-hot. The real question is, I repeat, How hot were those trodden on? and the answer to this I was to try to obtain after measuring the amount of water boiled away.

On returning to the ship this was estimated from the water which was left in the bucket (after allowing for that spilled over) at about 10 pounds. The stone, which it will be remembered was one of the hottest, if not the hottest in the pile, was found to weigh 65 pounds, and to have evaporated this quantity of water. It was, as I have said, a volcanic stone, and on minuter examination proved to be a vesicular basalt, the most distinctive feature of which was its porosity and non-conductibility, for it was subsequently found that it could have been heated red-hot at one end, while remaining comparatively cool at the top. I brought a piece of it to Washington with me and there determined its specific gravity to be 2.39, its specific heat 0.19, and its conductivity to be so extremely small that one end of a small fragment could be held in the hand while the other was heated indefinitely in the flame of a blowpipe, almost like a stick of sealing wax. This partly defeated the aim of the experiment (to find the temperature of the upper part of the stone), since only the mean temperature was found. This mean temperature of the hottest stone of the upper layer, as deduced from the above data, was about 1,200 deg. F., but the temperature of the surface must have been indefinitely lower. The temperature at which such a stone begins to show a dull red light in daylight is, so far as I am aware, not exactly determined, but is approximately 1,300 deg. to 1,400 deg. F.

To conclude, I could entertain no doubt that I had witnessed substantially the scenes described by the gentlemen cited, and I have reason to believe that I saw a very favorable specimen of a fire walk.

It was a sight well worth seeing. It was a most clever and interesting piece of savage magic, but from the evidence I have just given I am obliged to say (almost regretfully) that it was not a miracle.

EDITOR'S NOTE.—In a recent number of Nature there appeared some interesting illustrations of fire-walking by the natives of the Fiji Islands. Mr. Walter Burke in the Christchurch Weekly Press (July 16, 1902) and Dr. Robert Fulton in a condensed report in the Evening Star, give an account of this exhibition. According to Nature, the ceremony was performed on the island of M'Benga, near Suva, by members of the Nga Ngalita tribe, all of whom are credited with being specially gifted in the way of heat-resistance. In the center of a space cleared in a cocoanut grove was a circular pit, about 20 feet in diameter and 2 feet in depth, the earth from the center being piled round the periphery. Poles were placed radiating from the center, dry palm fronds were placed on these and firewood stacked above. Finally, large stones were heaped on the top until the whole pile was several feet in height. The fire was lit about forty-eight hours before the ceremony took place, and it was kept fed with fresh supplies of wood. Eventually the whole mass glowed with a white heat; it was not comfortable to stand within a few feet of it, and also it was dangerous, as large splinters of stone flew far and wide.

As the hour for the exhibition approached, the natives brought green saplings about 20 feet in length, armfuls of green branches, and masses of green vines of great length and considerable thickness. The following is from Mr. Burke's account:

"The fire is now sinking, and occasionally a large stone drops through. There is little smoke and the stones fairly glow. Now the workers close in. The smaller vines are fastened in loops at the ends of the long saplings. A loop is dropped over the end of a log not yet burnt out, and with loud chants the log is drawn out. This is repeated till no logs are left. The ends of the saplings continually burst into flames as they touch the stones. At last there seems to be nothing left in the pit but stones, some of which are shivered to pieces by the great heat. The large hawser-like vine now comes into use. This is thrown across the pit to one side, and with the saplings the men force it down into the glowing stones. Now dozens of willing hands pull at the ends, and the stones are turned over and over and flattened out. Many stones that were at the bottom are now on top, and *vice versa*. This is done until the stones present a fairly even surface, but critical men, still unsatisfied, probe among the stones with the saplings and turn the smoother side uppermost. While they are doing this, the green saplings blaze vigorously.

"The chief asks for silence and a hush falls on the scene. The assembled natives break into loud cries, and along a track in the jungle-like growth can be seen a party of ten Fijians fantastically dressed.

"Without hesitation or haste, they step on to the stones and walk around the pit, taking some ten to fifteen seconds to complete the circuit. They step off quickly, and in a moment great masses of green leaves are thrown on to the center. The fire-walkers rush back and press down the leaves with their feet and hands. The steam rising from the leaves envelops them in a cloud. Baskets of native food are passed in, and more green leaves are heaped over until a mound is made."

Dr. Fulton states that the man Dr. Smith and he examined before the fire-walking was of fine physique, with a pulse a little over 90 and the hands and feet cooler than the rest of the body. The feet were perfectly clean and odorless, and no preparation could be detected on them. The soles were yellowish-white, perfectly smooth and pliable, and like soft kid. The man wore a *sulu* (petticoat) of dry hibiscus bark and cana leaves, with small anklets of dry bracken. Each man as he walked kept his eyes on the stones. One man was examined afterward; his pulse was about 120; the soles of the feet seemed cool, if not cold, but on running the hand up the leg, a most pronounced difference in temperature was observable; on the calf, it was like that of a man in a high fever. None of his vegetable clothing was scorched, not even the dry bracken anklets, and the short, black, crisp hairs on the legs were not singed. Dr. Fulton went to the edge of the pit immediately after the ceremony and stirred up some of the stones with his foot. He stood for a second on one or two and found that they did not brown his boots, though evidently they were too hot to handle. He asked a native to get him one of the stones, and the man coolly walked up and began to move about the heated stones with his bare feet. This was not one of the "fire-walking" men, but one of those who had come from Suva. He raked out a piece of stone from the heap, but it was too hot to hold in the hand.

The explanation Dr. Fulton offers is as follows: The arrangements for heating were peculiar; if what was required was merely a surface of red-hot stones to walk upon, it would be easier to lay flat stones in the pit and to maintain a huge fire on them. The stones took forty-eight hours to get to their "proper" condition, and the subsequent cooking of the food took two days instead of an hour or so. The stones also were found to cool very slowly. The same stones are never used twice. They are gradually heated until split by the expansion of the contained water, and are then carefully arranged fractured side upward. The stone that was examined was an augite-andesite of ordinary type. Prof. Park, of the Otago School of Mines, found that, taking the thermal conductivity of copper as equal to 1000, that of andesite is 6.67, that is, it is a very feeble conductor of heat. In testing the radiation, iron being the standard at 100, andesite is 48. Thus the fractured, or inside, surface of the stone, owing to its slow conductivity does not receive nearly the amount of heat one would expect, and, owing to the slow radiation of heat, the foot is not burnt when coming into contact with the stone for a second or less; as a matter of fact, the sole of the foot was at no time in contact with a hot stone for more than half a second. The foot is naturally cold or artificially cooled; it is a well-known fact that one can bear with cold feet for a long time (up to a minute in some instances) heat from a fire which would be insupportable for five seconds at ordinary foot temperature.

A good deal has been written at various times on walking on heated stones or glowing embers. It is satisfactory to find that investigations by scientific men agree, on the whole, with one another in principle, and that a rational explanation is forthcoming for a sensational performance which unskilled white observers usually regard as mysterious or even as miraculous. The walking on glowing embers, which is well known in parts of India, as recently described in the Bulletin of the Madras Government Museum (vol. iv. 1901, p. 55), probably has another solution. The fire-walking ceremonies in India, Japan, and elsewhere require to be carefully studied by trained observers.

PRIMITIVE MAN AND HIS STONE IMPLEMENTS IN THE NORTH AMERICAN LOESS.

By WARREN UPHAM.

THE recent discovery of a human skeleton at the base of the Missouri valley loess near Lansing, Kan., as here related, brings evidence of a somewhat definite and great antiquity of man in this western hemisphere, and of his physical and racial character near the geographic center of our country at that early time. Newspapers in Kansas City gave the first accounts of this discovery last March, which thus, through the kindness of Hon. J. V. Brower, came to the knowledge of Prof. N. H. Winchell, of Minneapolis, president of the Geological Society of America, and myself, in Minnesota. We accordingly planned a visit to examine the locality and study the drift there in its relation to the recognized time divisions of the Ice Age. Our visit was on Saturday, August 9, in company with Profs. S. W. Williston and Erasmus Haworth, in charge of paleontology and geology at the State University, Lawrence, Kan., and with M. C. Long, curator of the Public Museum of Kansas City, Mo., and Sidney J. Hare and P. A. Sutermeister, also of that city. Mr. Long had examined the locality in March, with Mr. Edwin Butts, of Kansas City, civil engineer of the Metropolitan Street Railway; and they had obtained the skeleton for the Kansas City Museum. Again, in July, the drift section and the skeleton were examined by Prof. Williston, who published a short notice of them, entitled "A Fossil Man from Kansas," in Science for August 1.

An article which I present in the American Geologist for September, contains the folowing report of the discovery, as learned by inquiries and observations of the drift section and vicinity.

The skeleton was discovered February 20, 1902, in excavating a tunnel for storing fruit, vegetables, milk, butter, etc., in (and near the middle of the south edge of) the N. W. quar. of Sec. 28, T. 9 S., R. 23 E., close southwest of the Missouri River, and of the narrow bottom land that skirts it there on the southwest side; being on the farm of Martin Concannon and only a few rods from his house, at a distance of about two and one-half miles southeast from Lansing, and about eighteen miles northwest from Kansas City. His sons, Michael T. and Joseph F. Concannon, found the skull and most of the bones in their digging near the end of the tunnel, 69 to 71 feet from its entrance, 2 to 6 feet from its east side, and 1½ to 2 feet above its floor. The bones were disjointed, and were partly broken, decayed, and irregularly strewn about, but mainly they were huddled together in one place. The ribs and vertebræ were mostly decayed, so that they could not be preserved. Half of the broken lower jaw had been previously discovered, ten feet nearer the entrance and about one foot lower, that is, only about one foot above the floor of the tunnel; and near that spot a phalangeal bone was found embedded in the wall of the tunnel by one of our party. The other half of the lower jaw, matching that found before, was with the chief parts of the skeleton. No bones besides those of a single human skeleton were found in the entire excavation of the tunnel; nor were any implements, artificially chipped stone flakes, or other articles of human workmanship discovered. Mr. Concannon and his sons supplied light for our examination of the section displayed in the tunnel; and they kindly showed us where the bones were encountered, with detailed relation of the circumstances of their discovery. The skull was found entire, but had afterward been accidentally broken into many pieces, which Mr. Long fitted together, depositing it in the museum; but the other bones, including both parts of the lower jaw, were at the time of our visit in the possession of Mr. Butts, at whose home they were examined by all our party. From where the skeleton was found, the overlying loess deposit has a thickness of 20 feet, as determined by Mr. Butts, to the surface of the ground above. Measurements of the tunnel were also made by him, showing it to be 72 feet long, about 10 feet wide, and about 7½ feet high. Its walls are vertical to the height of about six feet, above which the top is flatly arched, with no other support than is supplied by the well known coherent texture of the loess formation in which this upper part of the tunnel is dug.

Upper Carboniferous limestone, determined from the abundant fossils collected by Mr. Hare in the region about Kansas City, outcrops at the site of the tunnel, and at much higher elevations close southeast, and somewhat farther away to the south, west, and northwest; but mainly it is covered and concealed by the extensive and very thick valley drift deposit of loess. The limestone, in a compact bed several feet thick, forms the floor of the tunnel, rising nearly two feet along its extent of 72 feet south-southeast into the bluff. Fragments of limestone and shale, with much earthy debris, rested on this floor along the area of the tunnel, having a variable thickness of 2 to 4 feet, but mainly about 2½ feet, and being thickest and most stony, as seen in the section, at the east wall of the tunnel. In the debris which thus formed the lower third of the excavation, fragments of the limestone, and of its associated thin shaly layers, are common up to 6 inches long, and several masses one to three feet long were encountered. One measuring 12 by 20 inches is embedded in the head of the tunnel, only two or three feet from the site of the skeleton, and at a little greater height. The skeleton lay in the upper foot of the debris, or perhaps in a hollow of its surface; but the half of the lower jaw found separate, a foot lower, was certainly embedded in the stony debris about a foot below its top where it is overlain by the loess. The Carboniferous limestone, from which its fragments in the debris appear to have been derived, outcrops within 50 feet southeast of Mr. Concannon's house, or only

about 150 feet southeast of the tunnel, having there a height of 50 or 60 feet above the tunnel floor. Thence the rock outcrop gradually rises southeastward as a spur ridge, attaining within the distance of an eighth of a mile a height of fully 125 feet above the floor of the tunnel, or about 150 feet above the ordinary level of the Missouri River; and the overlying loess rises onward to a height of 200 feet, or more, above the river, within another eighth of a mile, reaching there the general level of the top of the river bluffs and adjoining uplands.

According to the surveys of the Missouri River Commission, the extreme low and high stages of the river here during the period from 1873 to 1885 were respectively 735 and 760 feet above the sea level, the vertical range being 25 feet. The extreme high water was in 1881, being the highest within the thirty-five years since Mr. Concannon settled here; but it was exceeded, probably six or seven feet, by the high water of 1844, of which a record was made at Kansas City. The skeleton was at a height of 11 to 12 feet above the high water of 1881, or 772 feet, nearly, above the sea; and the house is about 3 feet higher, with the limestone outcrop extending from near it to about 900 feet above the sea, while the higher crests of the loess near by are at 950 feet, estimated approximately.

The coarse debris in the lower part of the tunnel contained, so far as we could observe, no glacial drift pebbles or stones of foreign origin, though they are frequent in the thin glacial drift which overlies the rock surfaces near. Many of these drift stones and bowlders are of the red Sioux quartzite, which overcrops 300 to 350 miles northward, in southwestern Minnesota, the northwest corner of Iowa, and the southeast part of South Dakota. It occurs in this Kansas drift mostly in small fragments, but often one to two feet in diameter, and occasionally even measuring five feet, or more, and weighing several tons. The southern boundary of the glacial drift, marking the limit of the continental ice-sheet in its extreme extension during the Kansan stage of the Glacial period, is at a line passing from east to west, as mapped by Chamberlin and McGee, about 12 or 15 miles south of the Kansas (commonly called the Kaw) River, and 25 to 30 miles south of Lansing.

Above the debris, which exhibits no marks of water assorting and deposition, the section, very clearly seen on each side and at the end of the tunnel, consists for its upper two-thirds of the very fine siliceous and calcareous yellowish gray silt called loess, containing no rock fragments nor layers of gravel and sand, excepting a thin layer of fine gravel, with limestone and shale pebbles up to a half inch in diameter, which was noted by Mr. Butts near the roof of the tunnel, having a thickness of about four inches and an observed extent of some 30 feet. Soon after the skeleton was embedded in the stony debris, or lay exposed on its surface, the geologic conditions that appear to have long prevailed were somewhat suddenly changed, and there ensued a more rapid deposition of the very fine waterlaid loess, deeply enveloping the bones before they had time to be generally removed by decay under the influences of the weather and infiltrating air and water. From the horizon of the skeleton, the loess extends up to the surface, a vertical thickness of 20 feet, and continues in a gently rising slope to a slight terrace on which Mr. Concannon's house stands. With similar irregularly eroded slopes, the loess continues upward to the general elevation of about 200 feet above the river within a distance of a fourth of a mile to a half mile southward and westward, attaining there a general level which was probably the surface of the river's flood plain at the maximum stage of the loess deposition. This plain appears to have been built up by gradual deposition from the broad river floods during many years and centuries, and to have stretched then over the present valley and bottom land of the Missouri, in this vicinity two to four miles wide, from which area it has been since removed by the river erosion. The great valley, as to its inclosing rock outcrops, is of preglacial age; it was not much changed by glacial erosion and deposition of the bowlder drift; but it was deeply filled by the loess, in which the valley was afterward re-excavated.

Prof. Williston noted a distinct darker layer of the loess, mostly about two inches thick but in part merely a threadlike line, traceable continuously through all the 72 feet of the west wall of the tunnel, running about 3 to 4 feet above the limestone floor, and one foot or a little more above the base of the loess. Pegs driven by our party at the line of this stratum along all its extent were seen to be in a straight plane, which by a hand level was found to have a descent of 7 or 8 inches from south to north in this distance. Other lines of almost horizontal stratification exist, but are less observable, throughout the loess, which is thus clearly shown to be an aqueous deposit. Several small gastropod shells were found in it by members of our party, but they were too delicate to be preserved for determination of their species. Three others, which have been carefully preserved by Mr. Butts, are said to have been found at the same place with the skeleton.

The admirable investigation of the physical and chemical characters of our loess deposits by Chamberlin and Salisbury in the paper of their joint authorship, "The Driftless Area of the Upper Mississippi Valley," published in the Sixth Annual Report of the United States Geological Survey, 1885, leaves no ground for doubt that the loess of the Mississippi and Missouri valleys was derived mainly from the North American ice-sheet, being a deposit of the flooded rivers during a stage of abundant ice melting, with considerable redistribution over the interfluvial upland areas by winds. A few years later, in 1891, an equally important work by McGee, "The Pleistocene History of Northeastern Iowa," appeared in the Eleventh Annual Report of the same survey, presenting most satisfactory and conclusive evidence that the chief stage of abundant and rapid deposition of the loess was when the ice-sheet still covered a large part of Iowa and stretched thence very far northward, but after it had relinquished the outer area of its drift, which extends south to central Missouri and northeastern Kansas. In 1894 a chronological classification of the series of our North American drift formations was published by Chamberlin in chapters which he contributed to the revised third edition of Prof. James Geikie's "Great Ice Age." Within the next four years this very useful classification, employing geographic nomenclature, was extended, and in part corrected, by Calvin, Bain, and others, of the Iowa Geological Survey; Leverett, of the United States Geological Survey; and the late Dr. George M. Dawson and his associates in the Geological Survey of Canada. It may also be added that the labors of Todd in Missouri and South Dakota, Winchell in Minnesota, and the present writer in Minnesota, North Dakota, and Manitoba, have likewise contributed toward our present systematic view of the sequence of events during the Ice age in this region, which must be brought before the reader to indicate the antiquity of the Lansing fossil man.

High epeirogenic elevation of the areas which became glaciated, both in America and Europe, to altitudes at least 1,000 to 4,000 feet above their present heights, as shown by submerged valleys and fjords, appears to have been the cause of the snow and ice accumulation of the Glacial period. The North American ice-sheet, in its time of general extension, had at least one very important interval of recession and readvance. The preceding time of ice accumulation is named the Albertan stage of the Glacial period, from the province of Alberta, Canada, and the ice-sheet then reached to southern Iowa; the interglacial retreat of the ice border, uncovering a wide belt as far northward, probably, as the south half of Minnesota, is called the Aftonian stage, from stratified beds with peat deposits covered by later glacial drift at Afton, Iowa; and the ensuing maximum advance of the ice-fields, to the outermost limits of the glacial drift in Kansas and Missouri, is the Kansan stage. These three stages undoubtedly were long; and I am inclined to estimate the duration of each as about 25,000 years.

From the maximum of the Kansan ice extension, there was a recession, called the Buchanan stage, from the county of this name in Iowa, followed by a renewed growth of the icefields, named the Iowan stage, each of which stages may have occupied 10,000 years. At the culmination of the Iowan stage the ice-burdened lands on both sides of the Atlantic sank from their former elevation to their present heights or mostly somewhat lower; and the more depressed areas have since been moderately re-elevated. By this subsidence, the temperate climate belonging now to the northern United States and southern Canada, with mild or warm spring and autumn and hot summers, was restored on the borders of the ice-sheet. Extensive melting over large marginal tracts of the ice followed; and the waters of this melting and of rains swept away much of the previously englacial and at last superglacial drift, depositing it beyond the ice boundaries. To this end of the Iowan stage belong the chief deposition of the loess and the Lansing man.

With slight re-elevation of the land and ordinary climatic vicissitudes, the mainly waning ice-sheet occasionally paused in its retreat, or even sometimes readvanced a little, whereby its bowldery drift became heaped at these times along its gradually receding boundaries, in belts of hills, knolls, and short ridges, called marginal moraines, which especially characterize the closing Wisconsin stage of the Ice age. Where the slope of the land declines northward, lakes were temporarily formed by the dam of the departing ice-sheet. One of these glacial lakes, named Lake Agassiz, in the basin of the Red River of the North and Lake Winnipeg, I have especially studied; and my estimate of the ratio of its shore erosion and beach accumulation, in comparison with those of Lake Michigan and others of our Laurentian lakes during the Postglacial period, indicates for this vast Lake Agassiz no longer duration than one thousand years, the time since the Ice age, according to many independent estimates being only about 7,000 years. Next comparing the duration of Lake Agassiz with the whole time of glacial retreat from the Iowan and loess-forming stage, I think that their ratio may have been approximately as one to five; or, in other words, that the glacial recession from the Iowa boundary to the north end of Lake Agassiz may have required no more than 5,000 years. With Postglacial time, we have, therefore, as the antiquity of the fossil man at Lansing, probably about 12,000 years; but the whole continuance of the Glacial period, from the beginning of the Albertan glaciation to the final melting of the ice-sheet in its Canadian central portion, according to these estimates, was probably about 100,000 years, ending some 7,000 years ago.

In a former paper contributed to the American Antiquarian in the March-April issue last year (vol. xxiii, pp. 81-88), I have explained how primitive men could migrate to this continent, coming from northeastern Asia and probably also from northwestern Europe, during the Glacial period. Even at the maximum of glaciation, they might advance along shores of land narrowly skirting the ice-sheet, like the land margin and the inland ice of Greenland. Mankind may have attained here, during the long course of our continental glaciation, nearly the same stages of culture as in their Solutrian and Magdalenian stages of late Glacial time in Europe. There man doubtless existed as early as the beginning of the ice age, fully 100,000 years ago, as I showed in a paper, "Primitive Man in the Somme Valley," published in the American Geologist for December, 1898; and even then the men of the Somme district and other parts of France and southern England made very serviceable paleolithic implements.

The Lansing discovery tells of a Glacial man, dolichocephalic, low-browed, and prognathous, having nearly the same stature as the average of our people to-day. As stated by Prof. Williston, he was contemporary with the Equus fauna, well represented in the Late Pleistocene deposits of Kansas, which includes extinct species of horse, bison, mammoth and mastodon, megalonyx, moose, camels, llamas, and peccaries.

It may reasonably be expected that many other evidences of the men of the loess-forming stage of the Ice age will be found, and will give some knowledge or hints of their mode of life. Two such items of testimony are already known in Iowa. Prof. F. M. Witter, superintendent of schools at Muscatine, in a paper read before the Iowa Academy of Sciences, in 1891, described "a rather rudely formed spear point of pinkish chert," found in the loess in that city about 12 feet from the surface, and an arrow point in the same loess section, "at least 25 feet below the surface." Both were discovered in place by Mr. Charles Freeman, the proprietor of a brickyard. Again, in volume xi, of the Iowa Geological Survey, published last year, Prof. J. A. Udden, reporting on Pottawattamie County, writes: "In tunneling the cellars into the loess hills back of Conrad Geisse's old brewery, on Upper Broadway in the same city (Council Bluffs), it is claimed that a grooved stone ax was taken out from under thirty feet of loess and forty feet from the entrance to the cellar excavation. The ax has an adhering incrustation of calcareous material on one side, evidently deposited by ground water. The loess at this place has possibly been disturbed by creeping or by rain wash, but its appearance suggests nothing of the kind. It is quite typical loess for this region. The ax was discovered by the workmen engaged in excavating the cellar and immediately shown to Engineer Robert F. Rain, who superintended the work, and who still has possession of it."

The extinction of the elephants, horses, and many other species of the animals that flourished here near the southern boundaries of the ice-sheet, may have been due to the prowess of the mighty huntsmen who killed and ate them, using their skins for clothing and as coverings of their lodges. Their stone-tipped spears and lances, even in that early time, many thousand years ago, were probably as effective, for the slaughter of such large animals, as any weapons in use by the Indians when Columbus discovered America.—The American Antiquarian.

EFFECT OF MARCONI'S WORK ON CABLE QUOTATIONS.

THAT the progress made by Mr. Marconi has caused some apprehension among the interests concerned is indicated by the market quotations of the securities of the more important cable companies, which are almost without exception, appreciably below the highest points touched last year. The following table from the London Economist illustrates the position:

	Highest 1902.	Present price.	Fall.
African direct 4 per cent mort. debs	101	98	3
Anglo-American def. ord	93¼	80¼	13
Anglo-American pref. ord	96¾	91	5¾
Commercial Cable 4 per cent debs	98⅝	94	4⅝
Direct Spanish ord	3⅝	3	⅝
Direct United States ord	10⅝	10	⅝
Eastern ord. stock	179	157½	21½
Eastern 4 per cent mort. debs	113¾	106⅝	7
Eastern and South African 4 per cent mort. debs	101⅞	100⅝	1¼
Eastern extension	13⅛	11	2⅛
Indo-European	42	40	2
West Indian and Panama 5 per cent debs	103	99¼	3¾
Western Telegraph 4 per cent debs	102¼	98¼	4

Eminent authorities have questioned the commercial value of the Marconi efforts, and it is admitted that difficulties which seem to be of a very serious nature have still to be overcome. Yet, when confident predictions of failure are put forward, it is well to remember the opinions that were expressed when the submarine cable had yet to prove itself a success. But so far as the investor in cable companies is concerned, there seems at present no cause for undue pessimism. Mr. Marconi has shown that messages can be sent across the Atlantic by his system, but he has yet to demonstrate that his system can be worked on a paying commercial basis; indeed, before this can be done various difficulties, notably that relating to the tapping of messages, must be obviated. The policy of those financially interested in cable companies should be one of watchfulness, but not of panic.

In this connection it may be well to note that Prof. Willis L. Moore, chief of the Weather Bureau, while on a visit to Yale, delivered a lecture on the work of the government weather reporting system. He says with regard to the use of wireless telegraphy to report the weather and to warn vessels of the approach of severe storms: "Wireless telegraphy has been used experimentally by the Weather Bureau. We found that no system yet devised worked with accuracy under varying atmospheric conditions. But wireless telegraphy is in the experimental stage yet. If it ever reaches that stage of perfection so that you can send several messages at the same time within the same magnetic field it will become very valuable to the meteorological service, for then we could flash our storm warnings from our coast stations out to vessels a long distance at sea. I do not think wireless telegraphy will interfere with submarine cables, for where permanent and rapid communication is needed the cable will be the better means. Many government officials, I think, are in favor of government control of wireless telegraph interests. Such control would prevent erection of interfering stations for one thing."

Electromotive Force of Ozone.—The decomposition of ozone produces heat, which, according to Berthelot, amounts to 29,600 gramme-calories per 48 grammes of ozone. A. Brand raises the question as to whether this considerable energy can be utilized wholly or in part for the production of electrical energy. As a matter of fact, a Grove gas battery can be constructed with oxygen and ozone as elements, the current passing from the oxygen electrode through the electrolyte to the ozone electrode. To determine how much of the energy is thus transformed it was necessary to find the E.M.F. of the cell. But since the E.M.F. of an oxygen electrode is not constant, the E.M.F. of an oxygen electrode and of an ozone electrode were separately determined by comparison with a standard mercury electrode consisting of mercury covered with mercurous sulphate and immersed in normal sulphuric acid. This determination was rendered difficult by the presence of H_2O or $H_2S_2O_8$ or both. Eventually the author found an amount of energy of 0.5 joule per coulomb. The total work of ozonization amounts to 0.642 joule per coulomb, so that there is a pretty high electrical efficiency. Gräfenberg, in a similar investigation, has found 0.56 for the E. M. F. of the ozone cell.—A. Brand, Ann. der Physik, No. 10, 1902.

THE NAVAL WAR GAME "WAR" BETWEEN THE UNITED STATES AND GERMANY.—VIII.

By FRED. T. JANE.*

DESPERATE CRUISER ACTION OFF MANILA.

To take the events foreshadowed in the previous article in order, the first incident to deal with is the attempt of the two "Wittelsbachs" to intercept the "Ohio." This attempt was a complete fiasco, the Germans never getting within a couple of hundred miles of their would-be quarry. Like the Duke of York in the song, who marched ten thousand men up a hill and then marched them down again, the two battleships got out a certain distance, waited, found coal getting short, and then came back again.

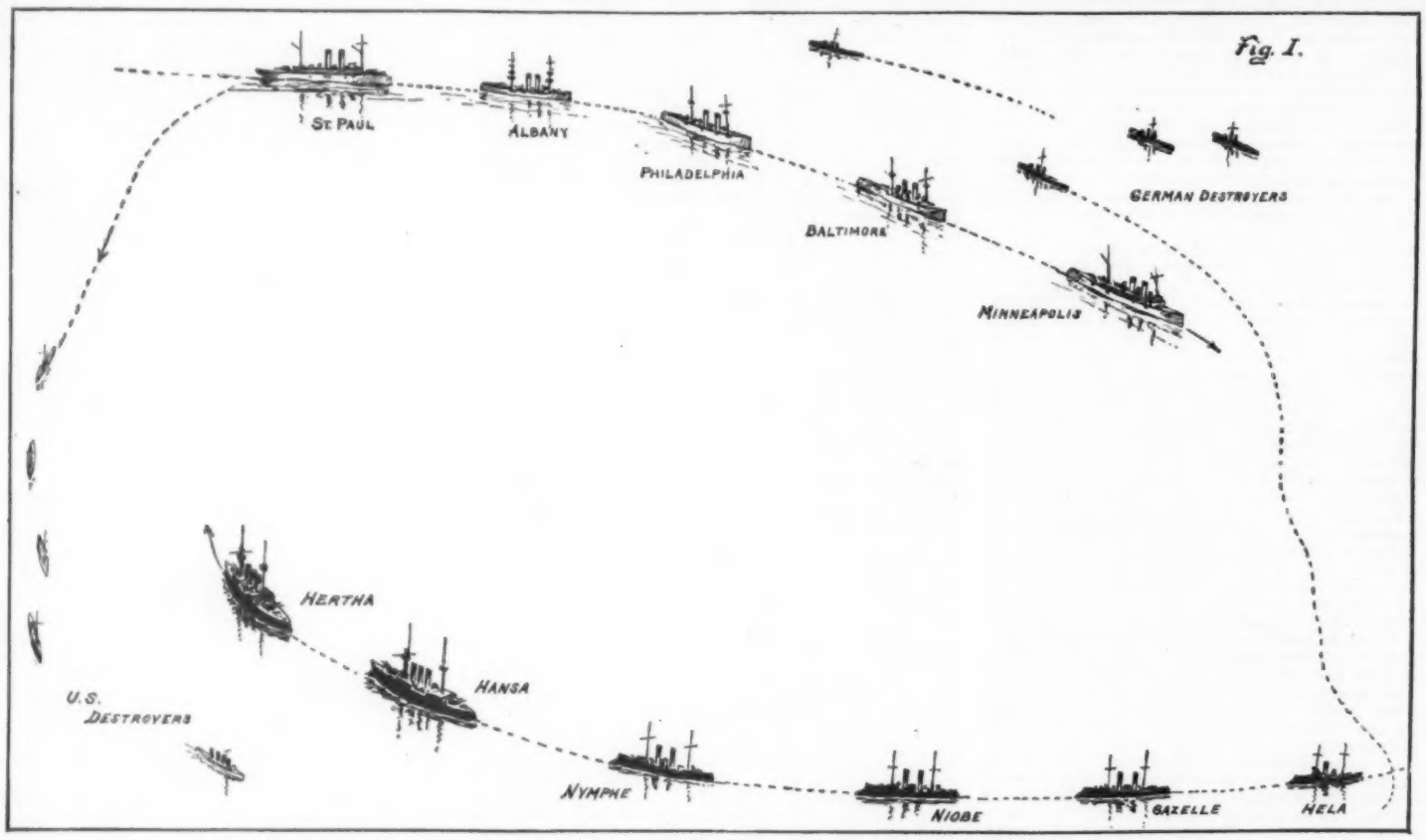
They had barely returned to the Philippines when the approach of the North Atlantic squadron was announced. The invading army made an attempt to carry the American base by assault, but this was umpired a failure. Then, having lost over 30 per cent of their original force, they were hastily re-embarked under the guns of the fleet, and the entire force retreated to Kiao Chau, leaving a couple of cruisers to mislead the American scouts.

As a result of this the American fleet delayed some while, but finally the cruisers running into Manila found the place still in American hands. Coaling hastily they put to sea again, and in the middle of the night fell in with some German vessels. These, inal idea; each was under strict orders to destroy hostile cruisers at any cost to himself. Given these conditions, the holocaust that resulted seems the only possible logical result. The range to begin with was short, it grew less as the battle advanced, and the sinking, drifting ships (as the diagrams indicate) reduced everything to a chaotic melée.

The method adopted for playing may be of interest. The ships were set up by the umpires under a cover. The lights were switched off and the cover removed. Then the players moved in gloom, speaking being strictly prohibited. Signaling was done by tapping a piece of tin attached to each model. This gave an indication of the signaler's whereabouts, as, the tin scintillated slightly. This rough-and-ready device worked excellently in simulating results equivalent to the real thing. For firing, the players moved to another room, the umpires, when they had gone, switching on the lights and noting positions. When the firing was over the table was covered, the players returned, the lights were switched off and the table uncovered. In the gloom it was absolutely impossible to distinguish friendly from hostile destroyers, and very hard to do so with larger ships.

Meanwhile the second German Home fleet, which had crossed the Atlantic, descended on Cuba, landing its expeditionary force near Havana. It claimed to have taken the forts in the rear and to have captured the place.

Eventually the umpires allowed this claim, on which



CRUISER NIGHT ACTION OFF MANILA. POSITIONS WHEN THE DESTROYERS ATTACKED.

turning on searchlights, opened fire and so secured an initial advantage. Immediately after they switched off and neither side used lights afterward.

DESPERATE CRUISER ACTION OFF MANILA.

The rival forces, though neither had any clear ide of the other's strength, were as follows:

GERMAN.	UNITED STATES
"Hertha."	"Minneapolis."
"Hansa."	"Albany."
"Gazelle."	"Baltimore."
"Nymphe."	Liner "St. Paul."
"Niobe."	"Philadelphia."
"Hela."	5 destroyers.
4 destroyers.	

When fire was opened the squadrons were each in line ahead. The destroyers disposed ahead in either case were recalled by both sides at once, and each senior captain was struck with the same idea. In brief, this idea was to drop the destroyers astern, and circle the big ships so that the enemy would blunder onto the waiting destroyers in the darkness.

Everything happened just as each had expected. The German ships circled and came into the American destroyers, which torpedoed every one of them at near range. At the same time the American ships blundered into the German boats to meet their fate.

The whole battle was over in less than five minutes. The big ships being disposed of, the destroyers fought each other, friend occasionally engaging friend, and at least one American destroyer was sunk by the "Minneapolis" as she went down. In the end a solitary American boat badly damaged was the sole survivor of the most sanguinary action on record.

Whether such a result is possible or likely in real war is an interesting question. Given the same conditions, it well may be. Each side believed that it alone had destroyers, each believed the other to be ignorant that any boats were about. Each was convinced that his plan of action was a brilliantly orig-

* Prepared especially for the SCIENTIFIC AMERICAN by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the SCIENTIFIC AMERICAN SUPPLEMENT of December 20, 1902.

the whole German squadron went into Havana Harbor, where it coaled and refitted after the Atlantic voyage.

The American home squadron consisting, save for the damaged "Iowa" and the old "Texas," of the "Alabama," "Kearsarge," "Missouri," "Maine," "Indiana," "Massachusetts," "Olympia," "San Francisco," "Cincinnati," "Detroit," 9 destroyers, and 2 torpedo boats, concentrated at Key West.

In the Far East the first German Home fleet lay idle at Kiao Chau, whither it had retired after raising the blockade of Manila. Outside the American squadron maintained a loose blockade, trying to draw the German out—without success.

Two big battles, therefore, remain pending; both likely to be of considerable interest. The result of them will be the result of the war, it having been decided not to continue operations any further than the practical destruction of one or other navy. At both centers, however, the combatants are so equally matched that both are shy of action.

(To be continued.)

Sparking Distances in Oils.—E. Jona has examined a large number of various oils with respect to their "dielectric strength." The charges were derived from an alternate-current transformer yielding voltages as high as 160,000. The oils differ greatly in their insulating powers, but the curves indicating the relation between voltage and maximum sparking distance all tend to become straight lines at voltages higher than 80,000. Natural olive oil shows the lowest insulating power. Benzol and fused paraffin are at the other extreme, and of these, benzol only shows a very slight increase of sparking distance for the higher voltages. It begins at 44 cm., and only rises to 47 cm. at a voltage of 160,000. The sparking distances in air show a very much greater increase with voltage than those in any liquid, but they also tend to a straight curve at the higher voltages. All desiccated oils show a smaller change of sparking distances with voltage than the corresponding oils do in their ordinary state. Toluol, xylol, and solution of colophony in xylol have nearly the same insulating power as benzol, but the modern vaseline oils used for transformers closely approach them. Benzol is, in any case, too dangerous on account of its inflammability.—E. Jona, Atti. Assoc. Elettrot. Ital., No. 4, 1902.

A BRIEF HISTORY OF OCEAN STEAMSHIPS.

By LAWRENCE IRWELL.

THERE is a general impression that the first steamship to cross the Atlantic was the "Savannah," which in 1819 made the voyage from the port of the same name to Liverpool in twenty-five days. The "Savannah," however, was not a steamship and was under sail more than two-thirds of the way across. She was a full-rigged packet ship, and had on her deck a small steam engine, by means of which motion was given to the craft in smooth water when the wind failed. The log is full of such entries as: "At 8 A. M. tacked to westward;" "took in the mizzen and foretop-gallant sails;" "got steam up and it came on to blow fresh;" "stopped wheels to clean the clinkers out of the furnace;" "started wheels;" and similar expressions which show that the "Savannah" was not a steamer in the proper sense of the term.

In 1838, the "Sirius" and the "Great Western" successfully made the journey from England to the United States; but five years before that date, Canadian enterprise accomplished the feat of bridging the Atlantic with a little vessel propelled by steam. This was the "Royal William"—named in honor of the reigning sovereign—which was built in the city of Quebec by a Scotchman, James Gondie, who had learned his business at Greenock, Scotland. The keel was laid in the fall of 1830, and her builder, then in his twenty-second year, wrote: "As I had the drawings and the form of the ship, at the time a novelty in construction, it devolved upon me to lay off and expand the draft to its full dimensions on the floor of the loft, where I made several alterations in the lines as improvements. The steamship being duly commenced, the work progressed rapidly, and in May following was duly launched, and before a large concourse of people was named the 'Royal William.' She was then taken to Montreal to get her engines, and I there superintended the finishing of the cabins and deck-work. When completed she had her trial trip, which proved quite satisfactory. Being late in the season before being completed, she only made a few trips to Halifax." The launching of this steamer was a great event in Quebec. The governor-general and his wife were present, the latter christening the ship. Military bands supplied the music, and the shipping in the harbor was gay with bunting. The city itself wore a holiday look. The "Royal William" propelled by steam alone, traded between Quebec and Halifax. While at the last-named place she attracted the attention of Mr. Samuel Cunard, the founder of the transatlantic line which bears his name. It has been said that the "Royal William" convinced him that steam was the coming power for ocean navigation. He asked many questions about her, took down the answers in a note book, and subsequently became a large stockholder in the ship.

The cholera epidemic of 1832 paralyzed business in Canada, and trade was at a standstill for a time. Like other enterprises at this date, the "Royal William" experienced reverses and she was doomed to be sold at sheriff's sale. Some Quebec gentlemen bought her, and resolved to send her to England to be sold. In 1833 the eventful voyage to England was made successfully, and without accident of any kind. The proportions of the "Royal William" were as follows: Builders' measurement, 1,370 tons; steamboat measurement, according to Canadian act of Parliament, 830 tons; length of keel, 146 feet; length of deck from

head to taffrail, 176 feet; breadth of beam inside the paddle-boxes, 29 feet 4 inches; outside paddle-boxes, 43 feet 10 inches; depth of hold, 17 feet 9 inches. It may be well to contrast these dimensions with those of the White Star liner "Cedric," launched at Belfast, Ireland, on August 21 last, which are: Length, 700 feet; breadth of beam 75 feet; carrying capacity, 18,400 tons. Her tonnage has been given in the reports as 21,000 tons and she is said to have accommodation for 3,000 passengers.

On August 4, 1833, the "Royal William," commanded by Capt. John McDougall, left Quebec via Pictou, N. S., for London, England, under steam, at 5 A. M. She made the passage in twenty-five days. Her supply of coal was somewhat over 330 tons (254 chaldrons). Her captain wrote: "She is justly entitled to be considered the first steamer that crossed the Atlantic by steam, having steamed the whole way." About the end of September, 1833, the "Royal William" was sold for £10,000, and was chartered to the Portuguese government to convey troops. Portugal was asked to buy her for the navy, but the admiral of the fleet not thinking well of the scheme declined to entertain the proposition. Capt. McDougall was master of the ship all this time. He returned with her to London and laid her up at Deptford. In July orders came to fit out the "Royal William" to run between Oporto and Lisbon. One trip was made between these ports and also a trip to Cadiz for specie for the Portuguese government. On his return to Lisbon, Capt. McDougall was ordered to sell the steamer to the Spanish government, through Don Evanston Castor da Perez, then the Spanish ambassador to Portugal. The transaction was completed September 10, 1834, when the "Royal William" became the "Ysabel Segunda," and the first war steamer the Spaniards ever possessed. She was ordered to the north coast of Spain against Don Carlos. Capt. McDougall accepted the rank and pay of a commander and by a special proviso was guaranteed £600 per annum, and also the contract to provide the squadron with provisions from Lisbon. The "Ysabel Segunda" proceeded to the north coast, and about the latter part of 1834 she returned to Gravesend, to be delivered up to the British government to be converted into an up-to-date war vessel at the imperial dock yard. The crew and officers were transferred to the "Royal Tar," chartered and armed as a war steamer, with six long 32-pounders, and named the "Reyna Governadoza," the name intended for the "City of Edinburgh," a steamer which had been chartered to form part of the squadron. When completed, she relieved the "Royal Tar" and took her place.

The "Ysabel Segunda" when ready, took out General Alava, the Spanish ambassador, and General Evans and most of his staff officers, to Saint Andero, and afterward to Saint Sebastian, having hoisted the commodore's pennant at Saint Andero. She was afterward employed in cruising between that port and Fuente Arabia, and acting in concert with the legion against Don Carlos until the time of service expired in 1837. She was then sent to Portsmouth, England, with part of the men discharged from naval service, and from there she was taken to London and detained in the city canal by Commodore Henry until the claims of the officers and crew on the Spanish government were settled, which was ultimately accomplished, and the officers and crew discharged from the Spanish service at the end of 1837. The ship was delivered up to the Spanish government without delay. After having her engines repaired, she was sent to Bordeaux, France, to have her hull overhauled. On being surveyed, however, it was found that her timbers were so much decayed that it was decided to build a new vessel to receive her engines. This was built at Bordeaux, and was added to the steam navy of Spain in 1853, her predecessor being converted into a hulk.

The foregoing is the history of the ship which played so important a part in the maritime annals of Canada, England, and Spain. Her model may be seen in the rooms of the Historical Society of the city of Quebec. A copy of this model formed part of the Canadian exhibit at the World's Fair at Chicago.

EARLIEST STEAMERS OF THE WORLD.

The earliest steamers the world ever saw, not reckoning the experimental craft constructed by such men as Fulton, Bell, Symington, and Watt, were those employed in the transatlantic trade. The "Savannah," although not a true steamship, as has already been explained, made the voyage from Savannah to Liverpool in twenty-five days, but the merit of her performance, as an illustration of the superiority of the engine over canvas, is of course, doubtful, as she was under sail during at least two-thirds of the trip. The credit of this voyage, however, belonged to the United States, and until about thirty-five years ago this country seemed to be ahead of all others, including Great Britain, in maritime matters. The famous Baltimore clippers gave a good lesson in ship building to European nations, and the superiority of American sailing yachts is almost universally recognized at the present day. It was not till twenty years after the voyage of the "Savannah" that the successful passage of two memorable vessels from England to the United States fairly established the era of what has been called the Atlantic steam ferry. These ships were respectively the "Sirius" and the "Great Western." The former had engines of 320 H. P. She left Ireland April 4, 1838, under the command of Lieut. Roberts of the British Royal Navy, bound for New York. The latter ship was a steamer of 1,340 tons, builders' measurement. She was commanded by Capt. Hoskins, R. N., and sailed from Bristol April 8 in the same year, also bound for New York. The "Sirius," it was calculated, had a start of her competitor by about 700 nautical miles, but it was known that her utmost capabilities of speed scarcely exceeded 8 knots an hour. On her trial trip between Blackwall (London) and Gravesend, the 'Great Western" made 11 knots an hour without difficulty. The result of the race was therefore, awaited with the utmost curiosity on both sides of the Atlantic. Contemporary records usually afford good evidence of the significance of past events, and the interest in this novel ocean journey was very great, to judge from the accounts with which the Liverpool and New York papers were filled. The following is in brief the narrative of the voyage of these two famous ships across the ocean:

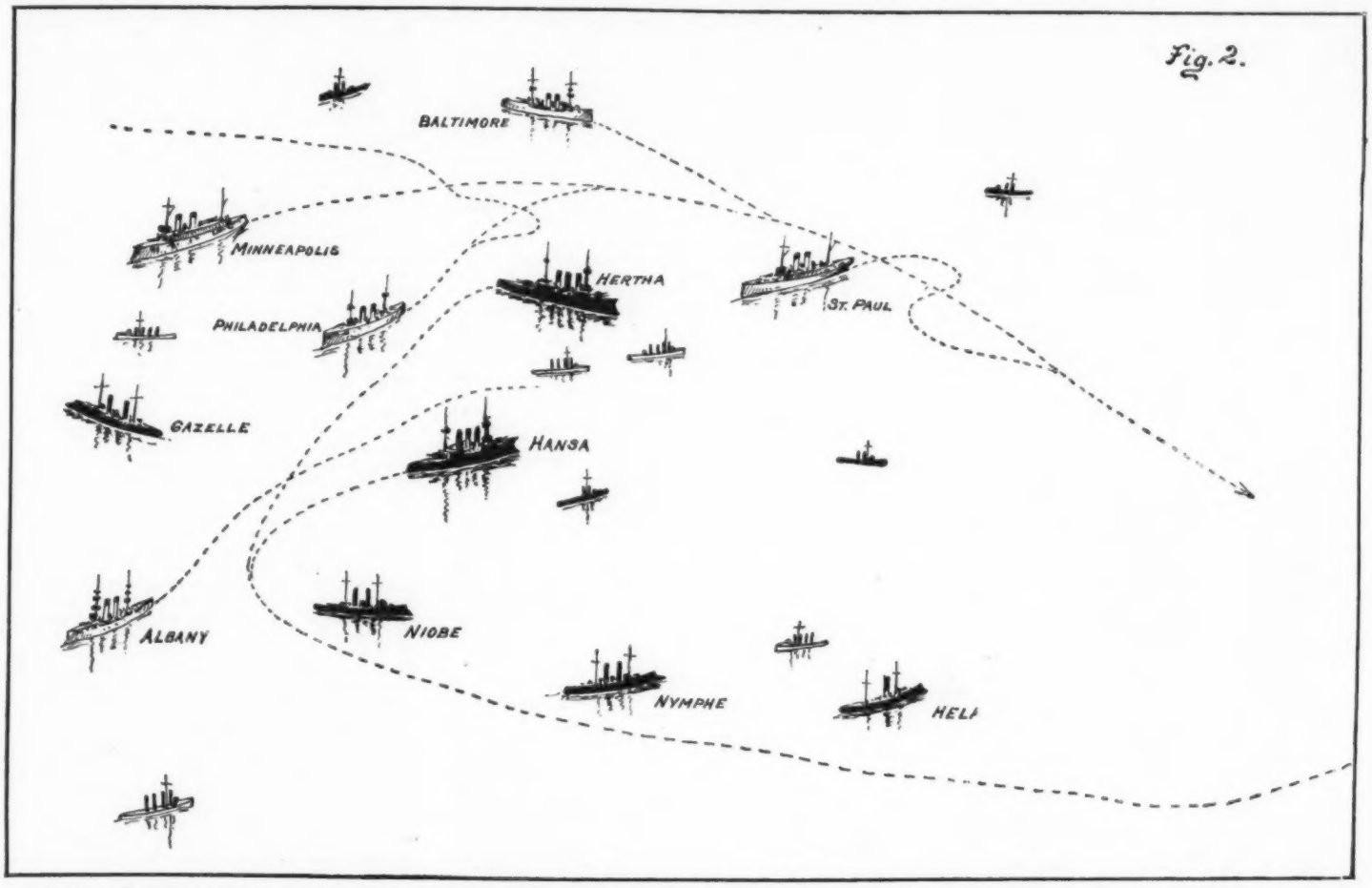
The "Sirius," after leaving Cork, encountered very heavy weather, which greatly retarded her progress. She arrived, however at Sandy Hook on the evening of Sunday, April 22, but going aground, she did not get into the North River until the following morning. When it was known that she had arrived, New York became agitated with excitement.

"The news," said the account published by the Journal of Commerce (New York), "spread like wildfire throughout the city, and the river became literally dotted all over with boats conveying the curious to and from the stranger. There seemed to be a universal voice in congratulation and every visage was illuminated with delight. A tacit conviction seemed to pervade every bosom that a most doubtful problem had been most satisfactorily solved. Visions of future advantage to science, to commerce, to moral philosophy began to float before the 'mind's eye.' Curiosity to travel through the old country, and to inspect ancient institutions, began to stimulate the inquiring. While all this was going on, suddenly there was seen over Governor's Island a dense black cloud of smoke spreading itself upward, and betokening another arrival. On it came with great rapidity, and about three o'clock in the afternoon its cause was made fully manifest to the accumulated multitudes at the Battery. It was the steamship 'Great Western,' of about 1,600 tons burden (probably net tonnage) under the command of Lieut. Hoskins, R. N. She had left Bristol on the 8th instant, and on the 23d was making her triumphant entry into the port of New York. This immense moving mass was propelled at a rapid rate through the waters of the Bay. She passed swiftly and gracefully round the 'Sirius,' exchanging salutes with her, and then proceeded to her destined anchorage in the East River. If the public mind was stimulated by the arrival of the 'Sirius,' it became almost intoxicated with delight upon view of the superb 'Great Western.' The latter vessel was only fourteen clear days out, and neither vessel had sustained a damage worth mentioning, although both vessels had encountered very heavy weather. The 'Great Western' averaged 186½ miles per day, and the 'Sirius' 130½ miles. The 'Great Western' averaged 7¾ miles per hour; the 'Sirius' barely averaged 5½ miles per hour."

Such was the first voyage made across the Atlantic by these two early steamships, and there is something of the true philosophy of history to be found in the interest which their advent created. It is worthy of passing note to learn what ultimately became of these vessels. The "Sirius," not proving staunch enough for the Atlantic service, was sent to open steamer communication between London and St. Petersburg (Russia), in which trade she was for several years successfully employed. The "Great Western" made regular trips from Bristol to New York till the year 1847, when she was sold to the Royal Mail Company and ran as one of their best ships till 1857, in which year she was broken up as being obsolete, and unable profitably to compete with the new class of steamers then building.

The success of these two vessels may be said to have completely established steam as a condition of the transatlantic voyage of the future. In October, 1838, Sir John Tobin, a merchant of Liverpool, seeing the importance of the intercourse so rapidly increasing between the old and the new worlds, dispatched on his own account a steamer to New York. She was built at Liverpool and was named after that city. She made the voyage to the United States in sixteen and a half days. It was now clearly proved that the service could be performed not merely with profit to those engaged in it, but with a regularity of speed with which the finest class of sailing vessels could not be expected to compete. "If any doubts still existed on these important points, the second voyage of the "Great Western" set them at rest, she having on this occa-

Fig. 2.



CRUISER NIGHT ACTION. POSITIONS OF THE CONTENDING SQUADRONS AT THE MOMENT THAT THE LAST CRUISER WAS TORPEDOED. AMERICAN DESTROYERS HAVE FOUR FUNNELS, GERMAN TWO.

sion accomplished the outward passage in fourteen days and sixteen hours, bringing with her the advices of the fastest American sailing ships which had sailed from New York long before her, and thus proving the necessity of having the mails conveyed by steamers."—Lindsay, History of Merchant Shipping.

EARLY MAIL CONTRACTS.

As early as 1838 the British government, being satisfied of the superiority of steamers over sailing ships, issued advertisements inviting tenders for the conveyance of the American mails by the former class of vessels. The owners of the "Great Western" having great confidence in the reputation of that ship, applied for the contract, but not a little to their chagrin, it was awarded to Samuel Cunard who, as far back as 1830, had proposed the establishment of a steam mail service across the Atlantic. The terms of the original contract were that for £55,000 per annum, Messrs. Cunard, Burns & MacIver should provide three ships, and make two voyages each month between Liverpool and the United States, leaving England at certain periods, but soon afterward it was considered more expedient to name fixed dates of departure on both sides of the ocean. Subsequently another ship was required to be added to the service and the amount of the payment was increased to £81,000 per annum. The steam mail service between Liverpool, Halifax, and Boston was regularly established in 1840, the first ship engaged in it being the "Britannia," the pioneer ship of the Cunard line.

A good idea of what these early steamships were may be obtained from Dickens' account of this same "Britannia," in which he crossed to the United States on his first visit in 1842. In one of his letters describing a storm by which the ship was overtaken, he unconsciously reflects the wondering regard with which the world still viewed the triumphant achievements of the marine engine. "For two or three hours," he wrote, "we gave it up as a lost thing. This was not the exaggerated apprehension of a landsman merely. The head engineer, who had been in one or the other of the Cunard vessels since they began running, had never seen such stress of weather; and I afterward heard Capt. Hewitt say that nothing but a steamer, and one of great strength, could have kept her course and stood it out. A sailing vessel must have beaten off, and driven where she would, while through all the fury of that gale they actually made 54 miles headlong through the tempest, straight on end, not varying their track in the least." What would the captain of one of the greyhounds of to-day think of such a feat? And, more interesting speculation still, what must Charles Dickens himself have thought of the performances he lived to witness as against this astonishing accomplishment on the part of old "Britannia"? There is a tendency to ridicule the early steamers as they appear in pictures, with their great boxes for the side-wheels, their tall, thin smokestacks and their heavily-rigged masts, which look as though their engines were regarded as quite auxiliary to their sail-power, and by no means to be relied upon. Contrasted with some of the leviathans of the present time, the steamers of half a century ago are no longer calculated to please the beholder, but it is nevertheless true that some very fine vessels were built while the marine engine was still in its infancy. In 1839 the following account of a new steamship appeared in an English publication, the Railway Magazine:

"An immense steamer, upward of 200 feet long, was lately launched at Bristol for plying between England and America; but the one now building at Carling & Co.'s Limehouse for the American Steam Navigation Co. surpasses anything of the kind hitherto made. She is to be named after our Queen, the "Victoria," will cost from £80,000 to £100,000, has about 150 men now employed daily upon her and is expected to be finished in November next. The extreme length is about 253 feet, but she is 237 feet between the perpendiculars, 40½ feet beam between the paddle-boxes, and 27 feet 1 inch deep from the floor to the inner side of the spar deck. The engines are two, of 250 H. P. each, with 6 foot 4 inch cylinders and 7 foot stroke. They are to be fitted with Hall's patent condensers in addition to the common ones. She displaces at 16 feet 2,740 tons of water. Her computed tonnage is 1,800 tons. At the water line every additional inch displaces 18½ tons. The average speed is expected to be about 200 nautical miles per day and consumption of coal about 30 tons. The best Welsh coal is to be used. It is calculated she will make the outward passage to New York in eighteen days, and the homeward in twelve, consuming 540 tons of coal out and 360 home. Expectation is on tiptoe for the first voyage of this gigantic steamer alongside of which other steamers look like fishing boats."

The steamers of the East India Company had made trips to the Cape of Good Hope nearly two years before the "Sirius" and "Great Western" sailed upon their first voyage.

The next route upon which regular steam navigation was opened, following upon that of the North Atlantic passage, was between Great Britain and India. The Nautical Magazine (English) for 1836, contains the original prospectus issued by a syndicate of London merchants upon the subject of steam communication with the East Indies. As an illustration of the almost incredible strides that have been made in ocean travel since that period, this piece of literature is most instructive. The circular opens by announcing that it is proposed to establish steam-traffic with India, extending, perhaps, even to Australia. It points out in sanguine terms how those distant parts of the world, by the contemplated arrangement, "will be reached at the outset in the short period of seventy-three days; and, when experience is obtained this time will in all probability be reduced by one-third. If two days be allowed for stoppages at stations, not averaging more than 1,000 miles apart throughout the line (route), the whole time for passing between the extreme points will only be sixty days, but a relay of vessels will follow, if the undertaking be matured, in which case twenty-four hours will be ample time at the depots, and a communication may be expected to be established and kept up throughout the year between England and Australia in fifty days. [The Australian city, Melborne, is 11,267 miles from London.] It is reasonably expected that Bombay will be reached in forty-eight days, Madras in fifty-five days, Calcutta in fifty-nine, etc." Letters now arrive at Bombay seventeen days after leaving England and at Calcutta three days later.

The writer in the Nautical Magazine gravely comments upon this scheme as quite plausible. He is indeed inclined to be anticipatory. Instead of seventy-three days to Australia, he is of opinion that the voyage may ultimately be accomplished in fifty, and that the table of time generally may be reduced by about one-third throughout; although to qualify his somewhat daring speculations, he admits that it is well to base the calculations on the safe side. But the East India Company asserted its prerogatives and put a stop to the scheme of the New Bengal Steamship Company, as the undertaking was to have been called. This raised a strong feeling of dissatisfaction, and the court of directors of the former concern was obliged to provide a substitute in lieu of the new undertaking which they had refused to sanction. Their own ships were quite unequal to the requirements of "prompt dispatch" which even then were beginning to agitate the minds of the somewhat conservative English people.

STEAM COMMUNICATION BETWEEN ENGLAND AND INDIA.

The possibility of establishing steam communication between England and India had been clearly demonstrated as early as the year 1825, when the "Enterprise," 480 tons and 120 H. P., sailed from London August 16, and arrived in Calcutta December 7. She was the first steamer to make the passage from England to India. It was not till the people of England began to petition, and the merchants of London to clamor for the adoption of steam-power in the Indian navigation that the magnates of the East India Company were stimulated into action. The "overland route" (Brindisi [Italy], Suez Canal, and Indian Ocean) had almost entirely superseded the sea voyage by way of the Cape of Good Hope, but the want of an efficient steamer service between London and Alexandria (Egypt) and between Suez and Bombay was greatly felt. Accordingly in December, 1836, the steamship "Atalanta" was sent from England to run on the Indian side of the route. She was a ship of something less than 650 tons burden, with engines of 210 H. P. The orders to her commander when leaving Falmouth were that he was to steam the whole distance, and was only to resort to sail power in case of a failure of machinery, in order fully to test the superiority of the marine engine over canvas. She sustained an average speed of about 8 knots an hour during the whole voyage, and but for her repeated stoppages would undoubtedly have made a quick passage to India. She was followed during March, 1837, by the "Bernice," of 680 tons and 230 H. P., which also made the trip without the assistance of her sails. She left England March 17 and arrived at Bombay June 13. As the race between the "Sirius" and the "Great Western" may be said to have inaugurated the steam navigation of the Atlantic, so did the voyage of the "Atalanta" and the "Bernice" first establish regular communication by steamer between Great Britain and India. There had, it is true, been desultory efforts of enterprise prior to this time, and the pioneer of the Peninsula & Oriental steamers, the "Royal Tar," had made a trip three years previously, but there had been no regular service. The London Times of November 11, 1838, pointed out the approaching change.

"Scarcely has the wonder created in the world by the appearance of the 'Great Western' and 'British Queen' begun to subside," says the editorial, "before we are again called upon to admire the rapid strides of enterprise by the notice of an iron steamship, the first of a line of steamers to ply between England and Calcutta, to be called the 'Queen of the East,' 2,618 tons and 609 H. P. When the vessels are ready, we understand the voyage between Falmouth and Calcutta will be made in 30 days."

From this time, ocean steamers began to multiply somewhat rapidly. One after another of the now famous shipping firms sprang up, beginning with the Cunard line in 1840. The first British steamship was registered at London in 1814; in 1842 there were 940 steamers registered; and the decay of the merchant sailing vessel was anticipated to such an extent that, in 1843, a member of the British House of Commons drew attention to the fact that the introduction of steamers and the displacement of smacks and other sailing vessels "would diminish the nursery for seamen."

A LONG PROCESS OF DEVELOPMENT.

The steamship of the present day is the result of a long process of development extending over about 100 years. Miller's experiments on a Scotch lake in 1788; Symington's "Charlotte Dundas," which steamed on the Forth and Clyde canal (Scotland), 1802; Fulton's "Clermont" on the Hudson in 1807; and Bell's "Comet" on the Clyde in 1812—these were the beginnings of this wonderful system of marine propulsion. At first steamers only traded on inland waters and coasting routes, but the traffic became gradually extended further seaward, until the Atlantic was crossed, as has already been described in detail. The hulls of steamships were at first of wood, followed about 1840 by iron, and about 1878 steel became the material used in construction. During this long period the form of the hull has undergone changes, chiefly to suit the system of propulsion adopted, and with the object of having as little resistance to the passage through the water as possible. Double hulls have been tried, but have not proved satisfactory, as the increased skin-resistance lessens the speed. Some curious devices have been tried to reduce this element of resistance, for example, cigar-shaped boats with inclined lower surfaces (the idea being that at high speed the ship would rise and skim along the water), and quite recently drums on rollers were used as a substitute for the ordinary hull, the rotation of the rollers being expected to do away with the frictional resistance of the passing water.

The engine and boiler have undergone many more changes than we have seen in the hull. On transatlantic and transpacific steamers, side-wheels have almost entirely disappeared, having been superseded by propellers. As the power of the engine is required to produce rotation on the shaft of the propeller, there is large scope for invention in the design, and as a result we have had beam engines, side-lever engines, steeple engines, and engines of a direct action placed horizontally, diagonally, or vertically as in screw-propelling machinery. Oscillating and other forms have also had their place. Many attempts to get a more direct turning action on the shaft have been tried in the rotatory form of engine, but until quite recently these have been found too wasteful in steam to admit of commercial success. The exception to this condition is an English invention, the Parsons steam turbine, to which reference will hereafter be made.

The steam generator has, like the engine, had various forms both in respect of strength and power of steam raising. In the earlier days of the steam engine, steam pressures only a few pounds above the atmosphere were used. Later Watt's great invention, the separate condenser, was utilized, and as a consequence a considerable addition to the effort on the piston was obtained, through the resulting vacuum. In some cases the boilers of the early steamers were made of copper, but this soon gave place to iron, which, in turn, retired in favor of steel. As the efficiency of a boiler depends largely on the extent of its heating surface, whereby the heat of the gases from the surface is taken up and imparted to the water, it was soon found that flues and tubes were of great advantage and boilers in which all hot gas from the furnace is led through a series of tubes surrounded by the water within the shell of the boiler to the chimney, or smoke-stack, are now usually employed in large steam vessels. Numerous attempts have been made to get a satisfactory working boiler in which the water is within the tubes and the hot gases play around them and more than one type of this class of boiler is now used at sea.

To favor economy of working, steam pressures have been raised, and the compound, triple and quadruple types of engine were devised to give the necessary expansion. Even to the mind of the marine engineer it must, upon reflection, seem a wonderful thing that the great engines of ocean steamers, although burning several hundred tons of coal per day, yet only require about 1½ pounds of coal to be burned every hour to give a horse power in the engines.

THE STEAM TURBINE.

The question of economy brings us to the most recent type of steam engine—the steam turbine. As has already been mentioned, engines of the rotatory type have been all great wasters of steam, and many attempts have been made to overcome this defect, as there was much in the simple, direct action of these machines to recommend them to engineers. The Parsons steam turbine, at first applied to driving dynamos for the production of electric energy, and afterward tried successfully in the small steamer "Turbinia," has given good results economically. To test its suitability for river steamers a boat was built on the Clyde, and favorable trials having been made, the people of Scotland have now an opportunity of traveling on this latest type of steam-driven vessel. She has been named the "King Edward," and at her trials on a measured mile, about a year ago, she attained a speed of nearly 20½ knots per hour, which is equal to 23½ statute miles. She is a "screw" steamer, capable of carrying 2,000 passengers. She was built at Dumbarton (Scotland) by the firm of Denny, and as side-wheelers have usually been adopted for the British coast-passenger traffic, she may be regarded as a new departure in the Old World, where changes come slowly. Her propellers revolve at from 700 to 1,000 revolutions per minute. Somewhat remarkable results have also been obtained with three other vessels fitted with the Parsons machinery—the "Turbinia," already referred to, a small ship of 100 feet in length, which attained a speed of 34½ knots; the British torpedo-boat destroyer, "Viper," 210 feet in length, which attained the extraordinary speed of 37 knots, or nearly 43 statute miles per hour; and the "Cobra," also one of the torpedo-boat destroyer class of naval vessels. The last-named literally "went to pieces" in September of last year, but the report upon the accident, which involved the loss of most of her crew, does not discredit the principle of the turbine.

As is well known, one of the most efficient forms of water-wheel is that of the turbine in which a number of curved blades fitted round an axle are made to revolve rapidly by the action of a jet or swift current of water. In the Parsons steam turbine, the water is replaced by steam, which is allowed at a high pressure to flow into a circular casing, in which there is a drum containing a great number of vanes of different sizes, and set at various angles. This drum in rotating turns the shaft into which it is fixed, and so gives motion to the machinery—or to the propeller of a steamship. In the older forms of rotatory engines, the steam, after pressing forward the moving parts, was finally ejected into the atmosphere, with a large part of its energy not utilized. The time has not yet been reached when any forecast of the future of the turbine engine can be made, as experiments with large ships are still in their infancy.

BRIEF TABLE OF REDUCTION OF TIME OF VOYAGE BETWEEN GREAT BRITAIN AND THE UNITED STATES.

Year.	Time.	Name of Ship.	Tons.
1862.	Under 9 days (from Queenstown)	Scotia	3,871
1869.	Under 8 days (from Queenstown)	City of Brussels	3,580
1882.	Under 7 days (from Queenstown)	Alaska	6,400
1889.	Under 6 days (from Queenstown)	City of Paris	10,669
1894.	Under 6 days (from Queenstown)	Lucania	12,950
1897.	Under 6 days (from Southampton)	Kaiser Wilhelm	14,349
1900.	Under 6 days (from Southampton)	Deutschland	16,502

PROGRESS IN SIZE OF STEAMERS.

		Tons.
1838.	Great Western first to exceed 200 feet in length	1,340
1845.	Great Britain first to exceed 300 feet in length	2,084
1871.	Oceanic (I) first to exceed 400 feet in length	3,867
1881.	Servia first to exceed 500 feet in length	7,392
1893.	Campania first to exceed 600 feet in length	12,952
1899.	Oceanic (II) first to exceed 700 feet in length	17,247
1858.	Great Eastern 680 feet long	18,918
1901.	Celtic 700 feet long	20,904

LOEWY'S SUMMARY OF LUNAR CONDITIONS.

THE pale companion that follows our earth in its wanderings through the universe has long been a puzzle to astronomers. The earth's satellite is the only celestial body that can be observed at a fairly close distance; and for that very reason the results that have so far been obtained have not satisfied our scientific curiosity. The well-known Parisian astronomer, Maurice Loewy, recently collected all the lunar observations which have been made, and has endeavored to bring some unity into the many conclusions which have been drawn.

Is it not after all rather daring to venture more than a vague hypothesis as to the mountains of the moon, its past, and its future fate? Despite innumerable, patient investigations, lucky discoveries, brilliant conceptions, few astronomers care to utter any definite theory of the genesis and evolution even of the earth. How much more to be distrusted are hypotheses of a body, distant from us thousands and thousands of miles, the soil of which we cannot dig, and the constituents of which we cannot analyze. But these objections, which were once insuperable, no longer baffle the astronomer. Scientific photography, with its wonderfully perfected apparatus, has furnished us with a wealth of new information relating to all celestial bodies, and has proved not a bad substitute for the pick of the miner and the balance of the chemist. And these improvements in the art of celestial photography have enabled us to study the moon narrowly. Astronomers have now the feeling that their lunar theories rest upon a firm foundation. No longer do they content themselves with simple descriptions of our satellite; boldly they furnish us with a history of the moon's evolution. Selenography has developed into selenology.

If we no longer agree with our forefathers in attributing to the stars an influence on the fate of individual persons, we at least recognize their influence on the form and development of the earth. Of all celestial bodies no doubt the sun is by far of most importance to us. But the moon, whose mass is but the one twenty-five millionth part of the sun's, may well lay claim to the second place in our attention. Closely allied in their wanderings through space, the earth and moon bear a most intimate relation to each other. At all times it has been recognized that the moon at least partially dispels the blackness of night. To be sure, we no longer believe that the moon is especially created for the purpose of protecting us during the temporary absence of the sun. Laplace proved that this result could be much more effectively and more easily reached. It would have been necessary merely to place the sun, moon, and earth in a straight line, and to start them on a journey through space with properly proportioned velocities.

The attraction of the moon, as we all know, is the cause of the tides. How important this rising and falling of the waters is to the navigator is well known. Perhaps the phenomenon of the tides at some future day may be of more significance to us. With the gradual exhaustion of the world's fuel supply the tides will prove a rich source of power. To be sure that power is not inexhaustible. The periodical rising and falling of the waters check the rotary movement of the earth; and the time must come when the day and the month will be of the same duration. Then the movement of the sea will cease, the earth will always turn the same side to its satellite, and the other side will no longer see the pale face of the moon.

Undoubtedly the attraction of the moon is the cause of atmospheric movements as well as of tides. But upon this point observations of sufficient precision have not as yet been made. Moreover, such atmospheric movements are much more difficult to determine. The study of the moon's positions has not as yet been practically applied to any great extent to meteorology. But this study, which by reason of the comparative nearness of the moon can be carried on with great accuracy, is of the utmost importance at sea. The mariner can calculate the changing geographical position of his vessel by the change in the moon's position.

For a long time the moon's natural history was an unexplored field. Not until the eye of the astronomer had been sharpened by means of the telescope, and photography furnished him with the means of fixing that which had been observed, were new features discovered in the well-known face of the moon. These observations offered new problems to the thinking astronomer. It was seen that the surface of the moon had its mountains, which were far higher than those of the earth. But these mountain formations by no means conform with terrestrial elevations. There are no ramified chains, no valleys having a common outlet, but circular pits skirted by steep mountainous walls. Through what stages did the moon pass before it acquired its present, perhaps permanent physiognomy? Is the moon inhabited, like our own earth? Is it to be regarded as a picture of our own past or of our future?

All bodies which revolve about the sun were originally gaseous fluids. On this one point all scientific cosmogonies agree. But it is not necessary to go back as far as that. Let us assume that a considerable portion of the moon's history has been lived through, and that the moon has been separated from the earth. As a fragment of the equatorial portion of the earth, the moon resembles the earth in form, structure and chemical composition. But it consists of terrestrial material which is of less average density than the material of the earth; the atmosphere which surrounds it, is less dense; poorly protected from atmospheric loss by radiation, of comparatively greater surface than volume, the moon cooled off far more rapidly than the earth. Much earlier its surface sank to a temperature at which most substances pass from the fluid to the solid state.

What will happen in the future? According to many investigators, connected, floating, superficial layers will be formed, buoyed up by the pressure of gases—fragments of the crust of the planet. Others believe the heavier particles, by reason of their greater density, will sink to the interior and form a solid kernel. According to a third hypothesis, the solid fragments will be remelted by the heat of the surrounding gases, until the entire mass has reached a uniform temperature and the process of solidification can proceed simultaneously. But mathematics can not fully solve the problem. Observation alone can give conclusive proof. For the formation of the earth the problem is still unsolved. A study of the illumination of the moon's surface justifies the assumption that a thin aerial envelope is still present. To be sure those who believe that the moon is inhabited can profit but little by this assumption. The atmosphere which may be attributed to the moon is of vanishing density compared with our own. The entire lunar surface is subjected to about the same physical conditions as the summit of the highest terrestrial mountain—small air pressure, excessive dryness, low temperature. And since life is not present on the summits of the highest mountains of the earth, it is extremely doubtful whether life is present on the moon. This conclusion can be justified by past observations. Nowhere has the telescope detected signs of floods and invasions, which are the necessary consequences of the movements of waters. The moon seems to have passed rapidly from the state of condensed steam to the solidification of water. Compared with the earth we may regard the moon either as a picture of our past or as the mirror of our future. According to Loewy the moon "is a planet preserved by the disappearance of water and air, the two agents which alone affect all changes."

How is it possible for two neighboring planets, created under the same conditions, subject to the same natural laws, to have passed through such different phases of evolution? The fatal consequences of an uneven distribution of atmospheres are greater in the case of the moon by reason of its lesser specific gravity, which is hardly the sixth of that of the earth. Imagine the earth subjected to the same conditions. The free gases would expand far more readily than they do now. The mechanical work performed by waterfalls would be reduced, and the smaller velocity of streams would lead to a more extensive vaporization and cooling. The internal volcanic forces might give rise to changes, which they are now incapable of effecting. Crevices would be formed through which the waters of the earth would penetrate to the interior, and soon the earth would become as dead as the moon.

Thus our mysterious companion through space proves to us that even among the stars it is the strong that conquer—that even to the stars the theory of the survival of the fittest is not inapplicable.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Silkworm in Spain.—The following has been received from Consular Agent A. E. Carleton, of Almeria:

The silkworm crop in Spain in 1901 was less by 121,000 pounds than in 1900. According to estimated figures, taken from El Defensor de Granada, the total product in 1901 was 2,189,000 pounds, and in the year preceding 2,310,000 pounds. A comparative table showing the production from the various provinces follows:

Province.	1900. Pounds.	1901. Pounds.
Valencia and Aragon....	924,000	919,600
Murcia and Orihuela.....	1,298,000	1,188,000
Sierra Segura	24,200	22,000
Almeria and Granada....	57,200	50,600
Extremadura	6,600	8,800
Total	2,310,000	2,189,000

In the province of Valencia, the same causes which lessened the output in 1900 prevailed in 1901; the silkworm, which had been damaged by the cold, was not strong enough to combat the various diseases which attacked the pod. In Murcia, also, the weather was responsible for the loss.

The French species continues to be cultivated almost entirely in Spain. The product in general has been somewhat less satisfactory than in 1900. For 1901, 11½ to 12 kilogrammes (25.3 to 26.4 pounds) of silkworm pod were necessary for a kilogramme of silk in the regions of Valencia and Murcia.

Of the total crop, 77,000 pounds were used in making fishing nets, leaving 2,112,000 pounds, which in 1901 produced in crude silk 176,000 pounds against 184,000 pounds in 1900; 171,600 pounds in 1899; 176,000 pounds in 1898; 160,000 pounds in 1897; and 264,000 pounds in 1896.

The Wool Trade of Marseilles.—The reviving importance of Marseilles as a source of supply for coarse carpet wools in the United States makes it a matter of moment to American buyers to understand that prices have stiffened in this market recently, mainly in consequence of the American demand. Henri Caune, who conducts the public auctions, and whose authority in these matters is generally recognized, has issued his report for the year, in which he says:

"The first months of the past year were calm and the disposition has been toward a lowering of prices. In the month of May business became more active. During June prices stiffened, and the increase commenced in July, continuing until the end of December. I have to report an increase in values of from 15 to 20 per cent upon wools for textiles and of from 20 to 30 per cent upon wools for upholstering and carpet trades. Local manufacturers have operated upon a large scale, in spite of the little choice represented by local stocks, and the general French trade has manifested more interest in our market, while foreign buyers, in consequence of numerous purchases, have contributed largely to the rise above mentioned. Unfortunately, I have also to note this year a shortage in arrivals amounting to 30,000 bales. The shortage during 1901 was 10,000 bales. This progressive shortage is due to three principal causes: (1) The excessive mortality existing more or less everywhere in the Mediterranean basin, but principally in Georgia, Syria, and Mesopotamia; (2) the local prices paid during the shearing season; and (3), finally, the large number of mills erected in countries of production.

"In spite of these conditions, our city continues to be the principal market for common wools, where domestic manufacturers and Americans will always find a most desirable choice. We arrive at the end of the year with a stock which I have never seen so reduced—that is to say, 6,600 bales. I have to say also that prices will remain very firm, at least until June, 1903, the next shearing season."

Armand Petit, another of the sworn wool brokers, says, in his review for 1902, that the domestic manufacturers are now interesting themselves principally in Bagdad wools. He adds:

"The United States now, as heretofore, is the most regular market for carpet wools. When the local stock is lacking in the qualities desired, advance orders have been executed directly in the countries of production, the merchandise being forwarded to Marseilles, inspected here, and reforwarded to the United States. The security offered by this method facilitates the entry into the United States of these wools at the lowest duty and permits of a daily development in operations of this character.

"We hope that the United States tariff will be modified in certain respects, and we give voice to the desire that Bagdad wools be no longer taxed with a prohibitive tariff, but put upon the same level as the Mossoul and Awassi wools. In consequence of the crossbreeding in Mesopotamia, the true Bagdad wools no longer exist, so to speak, and it requires the most expert knowledge to recognize these wools among the Mossouls and Awassis. These qualities are all pretty nearly identical, and according to the particular bales examined, give rise in the United States to various applications of the tariff rule. Under the present conditions, the majority of buyers hesitate to deal in these qualities, and we hope that a change in the law will be made whereby the wool trade will be placed upon the same footing."

The circumstance that the French wool trade comes to this market particularly to seek the Bagdad wools, because of their special qualities, and the intimation that because of crossbreeding these wools no longer exist in their original excellence, seems rather contradictory. Probably, the situation lies along middle ground somewhere. In my annual report* I have briefly explained how and why prices for carpet wools are automatically regulated in this market by the present tariff law.

There is no doubt that considerable quantities of very low grade Bagdad wool, which differ very little intrinsically from the Awassis, are received in this port, and that their occasional shipment to the United States results in complication requiring the most careful study of each bale upon its own merits.

The total wool receipts in Marseilles during the year 1902 were 100,235 bales, with 23,000 bales in stock at the end of 1901. The sales from local stock amounted to 116,635 bales, leaving a net stock of 6,600 bales at the close of 1902.—Robert P. Skinner, Consul-General at Marseilles.

Manufacture of Sugar in France.—There are at present in France 333 sugar factories distributed in 23 departments. The most important—about twelve—produce annually 100,000 sacks each. Four produce more than 200,000 sacks each. A sack contains 100 kilogrammes (220.46 pounds). These four largest sugar factories are situated at Pont d'Ardres (Pas de Calais), at d'Abbeville, at d'Escandœuvres, near Cambrai, and at Villenoy, near Meaux. All the factories of France manufactured, from 1900 to 1901, over 1,100,000 tons of sugar. This necessitated 8,700,000 tons of beet roots, occupying for cultivation more than 300,000 hectares (741,300 acres).

As to the harvest of 1902-3, although there is a considerable diminution in the weight of the beet roots and the yield of sugar, there is a considerable augmentation in the yield of refined sugar.

The duration of fabrication is only two months, or two months and a half at most, on account of the difficulty experienced in preserving the beet root, the factories opening in October and closing in December. Because of this necessity, the importance of a factory depends upon the quantity of beets it can procure daily by land or water transport. To increase this supply, the beets are now grated not only at the factory, but also in special establishments erected where the beets are raised, whence the juice is conducted through underground pipes to the factory. Some French factories are fed by as many as fifteen of these establishments, situated within a radius of half a mile to two miles.—Thornwell Haynes, Consul at Rouen.

Request for Trade Information.—The Bureau of Foreign Commerce has received from Fr. Buzzi d'J. of Trieste, Austria, a request for publication of the fact that he is desirous of obtaining the names of United States manufacturers of cotton-seed oil and of exporters of cotton waste, cotton strips, and engine-cleaning waste. Mr. Buzzi's request is hereby complied with for the information of the trade interests mentioned.

* To appear in Commercial Relations, 1902, now in the hands of the printer.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1554. January 26.—Iron and Steel Trades in Scotland—Joint-stock Companies in Scotland—Irrigation Works of India—Sugar Yield in Russia—Quinine Auction at Batavia—Cuban Customs Tariff.

No. 1555. January 27.—The Value of Rational Methods in Coke Production—*The Wool Trade of Marseilles—Manchester Exports to the United States—Civil Marriage Law of Ecuador—*Request for Trade Information.

No. 1556. January 28.—German Shipbuilding Progress on the Weser—*The Silkworm in Spain—New Mining Enterprise in Spain—Sulphuric Acid on Dried Fruit.

No. 1557. January 29.—Lumber and Timber Trade at Lourenco Marquez—Rouen-American Steamship Communication—*Manufacture of Sugar in France—Custom Formalities on the Russo-Chinese Frontier—Odessa-Naples-New York Steamship Line—*Mosquito Screens in Lourenco Marquez.

No. 1558. January 30.—The New German Tariff.

No. 1559. January 31.—The Forests of Canada—Mining Industry in Turkestan—Chinese Enterprise at Vancouver.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

The Bertin Enamel Varnish.—The production of this varnish, which bears the name of its inventor, consists:

1. In the employment or a liquid hitherto resistive to the manufacture of varnishes (mineral oil), after a chemical treatment which renders it suitable for this use.

2. In a treatment of the resins employed in the manufacture of varnishes.

For a quantity of ten liters of the oil sold in trade for lighting purposes, 250 grammes of quicklime are reduced to powder, as well as 50 grammes of manganese bisulphate; these two products are perfectly mixed by means of a sieve.

This mixture is placed at the bottom of a wide-mouthed receiver and slightly moistened with water. As soon as the mixture begins to be heated, and before the complete fusion of the lime, the precise moment being important, the oil is poured into the receiver, taking care not to separate the powder. The continuance of the oil on the mixed lime and manganese should be from 24 to 36 hours, until no globules are produced. Then the whole mixture is shaken quickly and left to repose until the liquid is clarified.

The operations should be conducted at a distance from any flame, the mixture, in consequence of the nitrated gases in the oil, being extremely detonating.

By this treatment, according to the author, nitrogen gas is present in quantity, and is free from heavy non-drying oils, which fall and then may enter into mixture with the resins without preventing the drying.

The dry resins, reduced to powder, are dissolved in boiling water.

A part of these resins falls to the bottom of the receiver, while the other part floats.

By pushing the ebullition of the resin in the water, the supernatant resinous part diminishes in volume, in proportion as the oils containing the resin are evaporated. This point is important, because, for siccative varnishes, only the heavy part of the resin, from which all the oil has been eliminated, can be employed.

For the purpose of freeing the resin from the salts of magnesia, or other salts, there is added to the water made use of 5 per cent of sodium hyposulphate.

As soon as the resin is melted, and the heavy parts have fallen to the bottom, according to the quality desired, the removal of the light parts and the decantation of the water are effected. Then they are mingled with the oil treated in advance, as has been mentioned above.—La Revue des Produits Chimiques, through Oil, Paint, and Drug Reporter.

Production of Modeling Wax.—Hager gives the following recipes for modeling wax in the Pharmaceutische Zeitung:

I. Yellow wax, 1,000 parts; Venice turpentine, 130 parts; lard, 65 parts; bole, 725 parts. The mixture when still liquid is poured into tepid water and kneaded until a plastic mass is obtained.

II. Summer Modeling Wax.—White wax, 20 parts; ordinary turpentine, 4 parts; sesame oil, 1 part; vermilion, 2 parts.

III. Winter Modeling Wax.—White wax, 20 parts; ordinary turpentine, 6 parts; sesame oil, 2 parts; vermilion, 2 parts. Preparation same as for I.

Cleaning Wall Paper.—To clean wall paper the Druggists' Circular and Chemical Gazette says that the dust should be first removed by lightly brushing, preferably with a feather duster, and the surface then gently rubbed with slices of moderately stale bread, the discolored surface of the bread being removed from time to time so as to expose a fresh portion for use. Care should of course be taken to avoid scratching the paper with the crust of the bread, and the rubbing should be in one direction, the surface being systematically gone over as in painting, to avoid the production of streaks.

Another method is as follows:

Mix 4 ounces of powdered pumice with 1 quart of flour, and with the aid of water make a stiff dough. Form the dough into rolls 2 inches in diameter and 6 inches long, sew each roll separately into a cotton cloth, then boil for 40 or 50 minutes, so as to render the mass firm. Allow to stand for several hours, remove the crust, and they are ready to use.

Frost Soap.—

Ceylon cocoanut oil	30	kilos
Soda lye, 38 deg. Bé	9	kilos
Camphor	1	kilo
Dissolved in—		
Spirit, 96 per cent	2½	liters
Flowers of sulphur	1	kilo
Potash lye, 39 deg. Bé	1	kilo

—Seifensieder Zeitung, Augsburg.

To Clean Marble.—The Druggists' Circular and Chemical Gazette gives this recipe:

Sodium carbonate	2 ounces
Chlorinated lime	1 ounce
Water	14 ounces

Mix well and apply the magma to the marble with a cloth, rubbing well in, and finally rubbing dry. It may be necessary to repeat this operation.

Hair-Curling Liquid.—There is an increasing demand for preparations by means of which the hair, especially that of the female sex, can be made to curl, without the use of the injurious curling iron. It must be stated that it is impossible to render straight hair curly without the aid of the iron or paper and other curlers. But it is possible on the other hand to make artificial curls more durable and proof against outside influences, such as especially dampness of the air. Below we give some reliable recipes:

	I.	II.
Water	70	80
Spirit of wine	30	20
Borax	2	—
Tincture of benzoin	—	3
Perfume	ad lib.	ad lib.

—Drogistische Rundschau, Zuerich.

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